Fire resistance of SNAP H110S fire collars when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005

Assessment Report

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Important disclaimer

Contents

1 Introduction

This report is an assessment of fire resistance of SNAP H110S fire collars when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005.

This report is prepared for meeting the evidence of suitability requirements of NCC 2019 Amt.1 (or earlier) Vol 1 Schedule 5 clause 2(c) as appropriate for FRL.

This report reviews and confirms the extent to which the reference fire resistance tests listed in section 2 meet the requirements of the standard fire test standards listed in section 4 of the report. The proposed variations to the tested construction presented in section 3 are subject to an analysis in Appendix B and the conclusions are presented in Section 5 of this report.

The field of applicability of the results of this assessment report is presented in Section 6 and subject to the requirements, validity and limitations of Section 7, 8 and 9.

2 Supporting Data

This assessment report refers to various test reports to support the analysis and conclusions of this report. They are listed below;

Table 1: Reference test data

Report Reference	Test Standard	Outline of Test Specimen
P112838-1000	EN 1366 Part 3:2009	A fire resistance testing of six (6)cast-in Suresnap fire collars protecting a 150-mm thick concrete floor slab penetrated by six (6) stack pipes.
P112838-1002	EN 1366 Part 3:2009	A fire resistance testing of six (6)cast-in Suresnap fire collars protecting a 150-mm thick concrete floor slab penetrated by six (6) stack pipes.
P112838-1003	EN 1366 Part 3:2009	A fire resistance testing of six (6)cast-in Suresnap fire collars protecting a 150-mm thick concrete floor slab penetrated by six (6) stack pipes.
P112838-1005	EN 1366 Part 3:2009	A fire resistance testing of six (6)cast-in Suresnap fire collars protecting a 150-mm thick concrete floor slab penetrated by six (6) stack pipes.
P112838-1006	EN 1366 Part 3:2009	A fire resistance testing of six (6)cast-in Suresnap fire collars protecting a 150-mm thick concrete floor slab penetrated by six (6) stack pipes.
P112838-1007	EN 1366 Part 3:2009	A fire resistance testing of six (6)cast-in Suresnap fire collars protecting a 150-mm thick concrete floor slab penetrated by six (6) stack pipes.
FSP 2050	AS 1530.4 -2014	A fire resistance testing of five (5) cast-in fire collars protecting a 150-mm thick concrete floor slab penetrated by five (5) stack pipes.
FSP 2072	AS 1530.4 -2014	A fire resistance testing of five (5) cast-in fire collars protecting a 150-mm thick concrete floor slab penetrated by five (5) stack pipes.

The reports P112838-1000, P112838-1002, P112838-1003, P112838-1005, P112838-1006, P112838-1007 were undertaken by BRE and sponsored by Snap Fire Systems has confirmed CSIRO can use the above reports for this assessment.

The report FSP2050 and FSP 2072 were undertaken by CSIRO North Ryde and sponsored by IG6 Pty Ltd.

3 Proposed Variations

The proposed construction shall be for pipes as tested in Table 1 and subject to the following variations;

- The inclusion of AUS PVC & sandwich core PVC pipes
- The inclusion of HDPE pipes, the pipes wall thickness and diameter may vary from max and min thickness as tested to the sizes shown on Table 2
- The inclusion of Polypropylene pipes such as Valsir Triplus and Rehau Raupiano where the pipe wall thickness and diameter may vary from the max and min thickness tested to those shown on Table 2
- All pipes shall be capped on fireside and uncapped on non-fireside
- The collar may be filled with Rockwool in lieu of a pipe as tested in P112838-1006 Specimen 2.
- All pipes may be with and without fittings in the body of the fire collar.
- When the annular gap between the pipe and collar is less than 10mm, no backfilling is required.
- When the annular gap between the pipe and collar is 10mm but less than 20mm, a 10mm or deeper sealant shall be installed.
- When the annular gap is greater than 20mm, a 30mm or deeper grout backfill shall be installed. Collars may be clustered together for applications up to 120 minutes for 150mm slabs. 10 in a row up to two rows e.g. 2x1, 3x1…10x1 and2x2, 2x3, 2x4….. 2x10 in any combination.

Table 2 – Proposed Pipe wall thickness

Pipe material	Nominal size (mm)	Wall thickness (mm)
HDPE	50	3
	56	3
	63	3
	75	3
	90	3.5
	110	4.3
PE	50	4.6
	63	5.8
	75	6.8
	90	8.2
	110	10
Triplus PP	50	2.3
	75	2.6
	90	3.1
	110	3.7
Raupiano PP	50	2.1
	75	2.4
	110	2.9

4 Referenced Standards

AS 1530.4-2014	Methods for fire tests on building materials, components and structures Part 4: Fire resistance tests of elements of building construction, Section 10 as appropriate for service penetrations.
AS 4072.1-2005	Components for the protection of openings in fire-resistant separating elements Part 1: Service penetrations and control joints

5 Conclusion

On the basis of the analysis presented in this report, it is the opinion of this Accredited Testing Laboratory that the tested prototypes described in Section 2 when varied as described in Section 3 will achieve the Fire Resistance stated below when submitted to a standard fire test in accordance with the test methods referenced in Section 4 and subject to the requirements of section 7, the validity of section 8 and limitation of section 9.

Table 3 – Pipe penetration details

Support Construction	Pipe Material	Snap Fire Collar	Pipe Diameter (mm)	Wall thickness (mm)	FRL
150mm thick concrete floor slab with an FRL of at least 120/120/120	PVC	**Snap H110S** Collars may be clustered together 10 in a row up to two rows e.g. 2x1, 3x1…10x1 and2x2, 2x3, 2x4….. 2x10 in any combination	40	2.1	-/120/120
			50	2 - 5	
			65	3	
			80	3.1	
			100	3.4 - 3.8	
	PVC – SC		100	3.5	
	HDPE		50	3	
			56	3	
			63	3	
			75	3	
			90	3.5	
			110	4.3	
	Polypropylene (Triplus)		50	2.3	
			75	2.6	
			90	3.1	
			110	3.7	
	Polypropylene (Rehau Raupiano)		50	2.1	
			75	2.4	
			110	2.9	
	PE		50	4.6	
			63	5.8	
			75	6.8	
			90	8.2	
			110	10	

6 Direct Field of Application of Results

The results of this report are applicable to floors exposed to fire from below

7 Requirements

It is required that the supporting construction is tested or assessed to achieve the required FRL up to the required FRL based on the assessed design in accordance with AS 1530.4.

It is required that the sealant be tested or assessed for an FRL of at least -/120/120 for gaps up to 20mm width.

Any variations concerning size, constructional details, loads, stresses, edge or end conditions that are other than those identified in this report, may invalidate the conclusions drawn in this report.

8 Term of Validity

This assessment report will lapse on 31st March 2025. Should you wish us to re-examine this report with a view to the possible extension of its term of validity, would you please apply to us three to four months before the date of expiry. This Division reserves the right at any time to amend or withdraw this assessment in the light of new knowledge.

9 Limitations

The conclusions of this assessment report may be used to directly assess the fire resistance performance under such conditions, but it should be recognised that a single test method will not provide a full assessment of the fire hazard under all fire conditions.

Because of the nature of fire resistance testing, and the consequent difficulty in quantifying the uncertainty of measurement, it is not possible to provide a stated degree of accuracy. The inherent variability in test procedures, materials and methods of construction, and installation may lead to variations in performance between elements of similar construction.

This assessment report does not provide an endorsement by CSIRO of the actual products supplied to industry. The referenced assessment can therefore only relate to the actual prototype test specimens, testing conditions and methodology described in the supporting data, and does not imply any performance abilities of construction of subsequent manufacture.

This assessment is based on information and experience available at the time of preparation. The published procedures for the conduct of tests and the assessment of test results are the subject of constant review and improvement and it is recommended that this report is reviewed on or, before, the stated expiry date.

The information contained in this assessment report shall not be used for the assessment of variations other than those stated in the conclusions above. The assessment is valid provided no modifications are made to the systems detailed in this report. All details of construction should be consistent with the requirements stated in the relevant test reports and all referenced documents.

Appendix A Supporting Test Data

A.1. Test report FSP 2050

On 2 October 2019, CSIRO North Ryde conducted a fire-resistance test on an 1150-mm x 1150-mm x 150-mm thick concrete slab penetrated by five (5) stack pipes protected by five Snap Fire Systems Cast-in fire collars.

The penetrated slab comprised a 150-mm thick concrete slab reinforced with a single layer of steel reinforcement providing a Fire Resistance Period (FRP) for insulation of 180 minutes in accordance with Table 5.5.1 of AS 3600:2018 - Concrete Structures.

The pipes used in the test are stated to be manufactured in accordance with:

- AS/NZS 1260 'PVC-U pipes and fittings for drain, waste and vent application'; and
- AS/NZS 4401 Plastics piping systems for soil and waste discharge (low and high temperature) inside buildings - Polyethylene (PE).

Specimen 1 – SNAP H110S Cast-in fire collar protecting a nominal 100-mm polyvinyl chloride sandwich construction (PVC-SC) stack pipe.

The SNAP Cast-in H110S fire collar comprised a 1.6-mm thick polypropylene casing with a 140-mm inner diameter and a 194-mm x 184-mm base flange. The 87-mm high collar casing incorporated a layer of 451-mm long x 85-mm wide x 4-mm thick Intumescent material. The closing mechanism comprised four equally spaced steel springs held with nylon fuse links. The springs were fabricated using SPR SS315-82 grade stainless steel wire having a diameter of 3.15-mm, with the springs acting against a layer of 316-grade stainless steel mesh measuring 503-mm x 83-mm as shown in drawing number H110S, dated 15 February 2019, by Snap Fire Systems Pty Ltd.

The penetrating service comprised a 110.8-mm outside diameter Iplex polyvinyl chloride sandwich construction pipe with a wall thickness of 3.51-mm fitted through the collar's sleeve. The annular gap between the pipe and the inside collar was left unprotected. The pipe projected vertically, 2000-mm above from the unexposed face of the concrete slab and 500-mm into the furnace chamber. The pipe was supported at nominally 500-mm and 1500 mm from the unexposed face of the slab. The pipe was open at the unexposed end and closed with a PVC end cap on the exposed end.

Specimen 2 – SNAP H110S Cast-in fire collar protecting a nominal 110-mm HDPE (PE100) stack pipe.

The SNAP Cast-in H110S fire collar comprised a 1.6-mm thick polypropylene casing with a 140-mm inner diameter and a 194-mm x 184-mm base flange. The 87-mm high collar casing incorporated a layer of 451-mm long x 85-mm wide x 4-mm thick Intumescent material. The closing mechanism comprised four equally spaced steel springs held with nylon fuse links. The springs were fabricated using SPR SS315-82 grade stainless steel wire having a diameter of 3.15-mm, with the springs acting against a layer of 316-grade stainless steel mesh measuring 503-mm long x 83-mm wide as shown in drawing number H110S, dated 15 February 2019, by Snap Fire Systems Pty Ltd.

The penetrating service comprised a 111.28-mm outside diameter Vinidex PE100 HDPE pipe with a wall thickness of 4.56-mm fitted through the collar's sleeve. The annular gap between the pipe and the inside collar was left unprotected. The pipe projected vertically, 2000-mm above from the unexposed face of the concrete slab and 500-mm into the furnace chamber. The pipe was supported at nominally 500-mm and 1500-mm from the unexposed face of the slab. The pipe was open at the unexposed end and closed with a PVC end cap.

Specimen 3 – SNAP H110S Cast-in fire collar protecting a nominal 40-mm polyvinyl chloride (PVC) stack pipe.

The SNAP Cast-in H110S fire collar comprised a 1.6-mm thick polypropylene casing with a 140-mm inner diameter and a 194-mm x 184-mm base flange. The 87-mm high collar casing incorporated a layer of 451-mm long x 85-mm wide x 4-mm thick Intumescent material. The closing mechanism comprised four equally spaced steel springs held with nylon fuse links. The springs were fabricated using SPR SS315-82 grade stainless steel wire having a diameter of 3.15-mm, with the springs acting against a layer of 316-grade stainless steel mesh measuring 503-mm long x 83-mm wide as shown in drawing number H110S, dated 15 February 2019, by Snap Fire Systems Pty Ltd.

The penetrating service comprised a 42.8-mm outside diameter polyvinyl chloride pipe with a wall thickness of 2.1-mm fitted through the collar's sleeve. The annular gap between the pipe and the inside collar was protected with a cardboard gasket then backfilled with grout flush to a depth of 60-mm and finished flush with the slab as shown in drawing titled "Specimen #3, 40 PVC Stack & H110S", dated 1 October 2019, provided by Snap Fire Systems Pty Ltd. The pipe projected vertically, 2000-mm above from the unexposed face of the concrete slab and 500-mm into the furnace chamber. The pipe was supported at nominally 500-mm and 1500-mm from the unexposed face of the slab. The pipe was open at the unexposed end and closed with a PVC end cap on the exposed end.

Specimen 4 – SNAP H110S Cast-in fire collar protecting a nominal 65-mm polyvinyl chloride (PVC) stack pipe.

The SNAP Cast-in H110S fire collar comprised a 1.6-mm thick polypropylene casing with a 140-mm inner diameter and a 194-mm x 184-mm base flange. The 87-mm high collar casing incorporated a layer of 451-mm long x 85-mm wide x 4-mm thick Intumescent material. The closing mechanism comprised four equally spaced steel springs held with nylon fuse links. The springs were fabricated using SPR SS315-82 grade stainless steel wire having a diameter of 3.15-mm, with the springs acting against a layer of 316-grade stainless steel mesh measuring 503-mm x 83-mm as shown in drawing number H110S, dated 15 February 2019, by Snap Fire Systems Pty Ltd.

The penetrating service comprised a 68.54-mm outside diameter polyvinyl chloride pipe with a wall thickness of 3 mm through the collar's sleeve. The annular gap between the pipe and the inside collar was protected with a cardboard gasket then backfilled with grout flush to a depth of 60-mm and finished flush with the slab. The pipe projected vertically, 2000-mm above from the unexposed face of the concrete slab and 500-mm into the furnace chamber. The pipe was supported at nominally 500-mm and 1500-mm from the unexposed face of the slab. The pipe was open at the unexposed end and closed with a PVC end cap on the exposed end.

Specimen 5 – SNAP H110S Cast-in collar protecting a nominal 80-mm polyvinyl chloride (PVC) stack pipe.

The SNAP Cast-in H110S fire collar comprised a 1.6-mm thick polypropylene casing with a 140-mm inner diameter and a 194-mm x 184-mm base flange. The 87-mm high collar casing incorporated a layer of 451-mm long x 85-mm wide x 4-mm thick Intumescent material. The closing mechanism comprised four equally spaced steel springs held with nylon fuse links. The springs were fabricated using SPR SS315-82 grade stainless steel wire having a diameter of 3.15-mm, with the springs acting against a layer of 316-grade stainless steel mesh measuring 503-mm long x 83-mm wide as shown in drawing number H110S, dated 15 February 2019, by Snap Fire Systems Pty Ltd.

The penetrating service comprised an 81.87-mm outside diameter polyvinyl chloride pipe with a wall thickness of 3.1 mm through the collar's sleeve. The annular gap between the pipe and the inside collar was protected with a cardboard gasket then backfilled with grout to a depth of 60 mm and finished flush with the slab. The pipe projected vertically, 2000-mm above from the unexposed face of the concrete slab and 500-mm into the furnace chamber. The pipe was supported at nominally 500-mm and 1500-mm from the unexposed face of the slab. The pipe was open at the unexposed end and closed with a PVC end cap on the exposed end.

Specimen 1-5 all maintain integrity and insulation without failure for 241 minutes duration of the test.

A.2. Test report FSP 2072

On 8 January 2020, CSIRO North Ryde conducted a fire-resistance test on an 1150-mm x 1150-mm x 150-mm thick concrete slab penetrated by five (5) stack pipes protected by five Snap Fire Systems fire collars. Only specimen 1 and 2 are discussed in this assessment.

The penetrated slab comprised a 150-mm thick concrete slab reinforced with a single layer of steel reinforcement providing a Fire Resistance Period (FRP) for insulation of 180 minutes in accordance with table 5.5.1 of AS 3600:2018 - Concrete Structures.

The pipes used in the test are stated to be manufactured in accordance with:

• AS/NZS 2492:2007 'Cross-linked polyethylene (PE-X) pipes for pressure applications'; and

• AS/NZS 7671:2010 Plastics piping systems for soil and waste discharge (low and high temperature) inside buildings— Polypropylene (PP).

Specimen 1 – SNAP H110S Cast-in fire collar protecting a nominal 110-mm Valsir Triplus polypropylene stack pipe with bell-end joint inside collar.

The SNAP Cast-in H110S fire collar comprised a 1.6-mm thick polypropylene casing with a 140-mm inner diameter and a 194-mm x 184-mm base flange. The 248-mm high collar casing incorporated a layer of 451-mm long x 85-mm wide x 4-mm thick Intumescent material. The closing mechanism comprised four equally spaced steel springs held with nylon fuse links. The springs were fabricated using galvanised steel wire having a diameter of 3.15-mm, with the springs acting against a layer of 316-grade stainless steel mesh measuring 503-mm x 83-mm as shown in drawing number H110S, dated 15 February 2019, by Snap Fire Systems Pty Ltd.

The penetrating service comprised a 110-mm outside diameter Valsir Triplus polypropylene pipe with a wall thickness of 3.7-mm fitted through the collar's sleeve. The annular gap between the pipe and the inside collar was left unprotected. The pipe projected vertically, 2000-mm above from the unexposed face of the concrete slab and 500-mm into the furnace chamber. The pipe was supported at nominally 500-mm and 1500-mm from the unexposed face of the slab. The pipe was open at the unexposed end and closed with a Superwool plug on the exposed end.

Specimen 2 – SNAP H110S Cast-in fire collar protecting a nominal 110-mm Rehau Raupiano polypropylene stack pipe.

The SNAP Cast-in H110S fire collar comprised a 1.6-mm thick polypropylene casing with a 140-mm inner diameter and a 194-mm x 184-mm base flange. The 248-mm high collar casing incorporated a layer of 451-mm long x 85-mm wide x 4-mm thick Intumescent material. The closing mechanism comprised four equally spaced steel springs held with nylon fuse links. The springs were fabricated using galvanised steel wire having a diameter of 3.15-mm, with the springs acting against a layer of 316-grade stainless steel mesh measuring 503-mm x 83-mm as shown in drawing number H110S, dated 15 February 2019, by Snap Fire Systems Pty Ltd.

The penetrating service comprised a 110.8-mm outside diameter Rehau Raupiano polypropylene pipe with a wall thickness of 2.92-mm fitted through the collar's sleeve. The annular gap between the pipe and the inside collar was left unprotected. The pipe projected vertically, 2000-mm above from the unexposed face of the concrete slab and 500-mm into the furnace chamber. The pipe was supported at nominally 500-mm and 1500-mm from the unexposed face of the slab. The pipe was open at the unexposed end and closed with a Raupiano end cap on the exposed end

Both specimen 1 and 2 were able to maintain integrity and insulation for 241 minutes duration of the test without failure.

A.3. Test report P112838-1000

On 5 September 2018, BRE Global Ltd conducted a fire resistance test in accordance with EN1366 Part 3: 2009 on a concrete floor, nominally 1800mm x 1800mm x 150mm-thick, penetrated by 6 pipes which were protected by Suresnap H110S fire collars. Only specimens 2,3,4 and 6 are discussed in this assessment.

The Suresnap cast-in H110S fire collar comprised a 1.9-mm thick polypropylene casing with a 138-mm inner diameter and a 194-mm x 184-mm rectangular base flange. The 248-mm high collar casing, (cut down in height to match the floor thickness after casting), incorporated a 451-mm x 85-mm x 4-mm thick intumescent material and a rubber ring seal. The closing mechanism comprised four 3.15-mm diameter galvanised steel springs bound with nylon fuse links and a 503-mm x 83-mm x 0.25-mm thick stainless steel mesh.

Penetration 2 H110S cast-in collar protecting a nominal 100mm PVC pipe stack with fitting inside the collar.

The penetrating service comprised a 110-mm Optima PVC pipe with a wall thickness of 6.6-mm, and a 100-mm long PVC coupling with a wall thickness of 6.6-mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends.

Penetration 3 H110S cast-in collar protecting a nominal 50mm PVC pipe stack with fitting inside the collar

The penetrating service comprised a 50-mm Optima PVC pipe with a wall thickness of 3.7-mm, and a 50-mm long PVC coupling with a wall thickness of 3.7-mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends.

Penetration 4 H110S cast-in collar protecting a nominal 50mm PE-HD pipe stack

The penetrating service comprised a 50-mm Geberit PE-HD pipe with a wall thickness of 3-mm, fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends.

Penetration 6 H110S cast-in collar protecting a nominal 110mm PE-HD pipe stack

The penetrating service comprised a 110-mm Geberit PE-HD pipe with a nominal wall thickness of 4.3-mm, fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500- mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends.

The results of these specimens are summarised in section A10.

A.4. Test report P112838-1002

On 13 September 2018, BRE Global Ltd conducted a fire resistance test in accordance with EN1366 Part 3: 2009 on a concrete floor, nominally 1800mm x 1800mm x 150mm-thick, penetrated by 6 pipes which were protected by Suresnap H110S fire collars. Only specimens 2,3,4 and 6 are discussed in this assessment.

The Suresnap cast-in H110S fire collar comprised a 1.9-mm thick polypropylene casing with a 138-mm inner diameter and a 194-mm x 184-mm rectangular base flange. The 248-mm high collar casing, (cut down in height to match the floor thickness after casting), incorporated a 451-mm x 85-mm x 4-mm thick intumescent material and a rubber ring seal. The closing mechanism comprised four 3.15-mm diameter galvanised steel springs bound with nylon fuse links and a 503-mm x 83-mm x 0.25-mm thick stainless steel mesh.

Penetration 2 H110S cast-in collar protecting a nominal 50mm PP pipe stack with fitting inside the collar.

The penetrating service comprised a 50-mm Valsir Triplus PP pipe with a wall thickness of 1.8-mm, and a bell end with a wall thickness of 1.8-mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends. On the unexposed face, the annular gap between the pipe and slab was sealed with non-shrink grout backfill.

Penetration 3 H110S cast-in collar protecting a nominal 110mm PP pipe stack with fitting inside the collar

The penetrating service comprised a 110-mm Valsir Triplus PP pipe with a wall thickness of 3.4-mm, and a bell end with a wall thickness of 3.4mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends.

Penetration 4 H110S cast-in collar protecting a nominal 100mm PVC pipe stack

The penetrating service comprised a 110-mm Terrain PVC pipe with a wall thickness of 3.2-mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends.

Penetration 6 H110S cast-in collar protecting a nominal 100mm PVC pipe stack

The penetrating service comprised a 110-mm Terrain PVC pipe with a wall thickness of 3.2-mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends. On the unexposed face, the annular gap between the pipe and slab was sealed with a 10-mm bead of Silicone.

The results of these specimens are summarised in section A10.

A.5. Test report P112838-1003

On 17 September 2018, BRE Global Ltd conducted a fire resistance test in accordance with EN1366 Part 3: 2009 on a concrete floor, nominally 1800mm x 1800mm x 150mm-thick, penetrated by 6 pipes which were protected by Suresnap H110S fire collars. Only specimen 4 is discussed in this assessment.

The Suresnap cast-in H110S fire collar comprised a 1.9-mm thick polypropylene casing with a 138-mm inner diameter and a 194-mm x 184-mm rectangular base flange. The 248-mm high collar casing, (cut down in height to match the floor thickness after casting), incorporated a 451-mm x 85-mm x 4-mm thick intumescent material and a rubber ring seal. The closing mechanism comprised four 3.15-mm diameter galvanised steel springs bound with nylon fuse links and a 503-mm x 83-mm x 0.25-mm thick stainless steel mesh.

Penetration 4 H110S cast-in collar with a Manifold Recess Former protecting a nominal 100mm PVC pipe stack

The penetrating service comprised a 100-mm Terrain PVC pipe with a wall thickness of 2-mm fitted through the collar's sleeve. The penetration was recessed into the slab using a Manifold Recess Former. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends.

The result of the specimen is summarised in section A10.

A.6. Test report P112838-1005

On 21 September 2018, BRE Global Ltd conducted a fire resistance test in accordance with EN1366 Part 3: 2009 on a concrete floor, nominally 1800mm x 1800mm x 150mm-thick, penetrated by 6 pipes which were protected by Suresnap H110S fire collars. Only specimen 3 is discussed in this assessment.

The Suresnap cast-in H110S fire collar comprised a 1.9-mm thick polypropylene casing with a 138-mm inner diameter and a 194-mm x 184-mm rectangular base flange. The 248-mm high collar casing, (cut down in height to match the floor thickness after casting), incorporated a 451-mm x 85-mm x 4-mm thick intumescent material and a rubber ring seal. The closing mechanism comprised four 3.15-mm diameter galvanised steel springs bound with nylon fuse links and a 503-mm x 83-mm x 0.25-mm thick stainless steel mesh.

Penetration 3 H110S cast-in collar protecting a nominal 50mm PVC pipe stack

The penetrating service comprised a 55-mm Terrain PVC pipe with a wall thickness of 2.0-mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends. On the unexposed face, the annular gap between the pipe and slab was sealed with non-shrink grout backfill.

The result of the specimen is summarised in section A10.

A.7. Test report P112838-1006

On 26 September 2018, BRE Global Ltd conducted a fire resistance test in accordance with EN1366 Part 3: 2009 on a concrete floor, nominally 1800mm x 1800mm x 150mm-thick, penetrated by 6 pipes which were protected by Suresnap H110S fire collars. Only specimens 2,3 and 6 are discussed in this assessment.

The Suresnap cast-in H110S fire collar comprised a 1.9-mm thick polypropylene casing with a 138-mm inner diameter and a 194-mm x 184-mm rectangular base flange. The 248-mm high collar casing, (cut down in height to match the floor thickness after casting), incorporated a 451-mm x 85-mm x 4-mm thick intumescent material and a rubber ring seal. The closing mechanism comprised four 3.15-mm diameter galvanised steel springs bound with nylon fuse links and a 503-mm x 83-mm x 0.25-mm thick stainless steel mesh.

Penetration 2 H110S cast-in collar with 50mm Rockwool Plug

The penetrating service comprised a disc of Rockwool to 50mm depth bolted to a H110S plastic cap. The Rockwool was held in place with a vertical threaded rod, oversized washer on the base and nuts on the top and bottom. A dob of silicone sealant on the top unexposed nut. The Rockwool and cap were inserted into the top of the collar such that the cap was flush with the top of the. There was no pipe penetrating the collar.

Penetration 3 H110S cast-in collar protecting a nominal 110mm PE100 pipe stack

The penetrating service comprised a 110-mm Onorm PE100 pipe with a wall thickness of 10-mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends.

Penetration 6 H110S cast-in collar protecting a nominal 50mm PE100 pipe stack

The penetrating service comprised a 50-mm Onorm PE100 pipe with a wall thickness of 4.6-mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends. On the unexposed face, the annular gap between the pipe and slab was sealed with non-shrink grout backfill.

The results of these specimens are summarised in section A10.

A.8. Test report P112838-1007

On 28 September 2018, BRE Global Ltd conducted a fire resistance test in accordance with EN1366 Part 3: 2009 on a concrete floor, nominally 1800mm x 1800mm x 150mm-thick, penetrated by 6 pipes which were protected by Suresnap H110S fire collars. Only specimens 2,3 and 6 are discussed in this assessment.

The Suresnap cast-in H110S fire collar comprised a 1.9-mm thick polypropylene casing with a 138-mm inner diameter and a 194-mm x 184-mm rectangular base flange. The 248-mm high collar casing, (cut down in height to match the floor thickness after casting), incorporated a 451-mm x 85-mm x 4-mm thick intumescent material and a rubber ring seal. The closing mechanism comprised four 3.15-mm diameter galvanised steel springs bound with nylon fuse links and a 503-mm x 83-mm x 0.25-mm thick stainless steel mesh.

Penetration 2 H110S cast-in collar protecting a nominal 110mm PP pipe stack

The penetrating service comprised a 110-mm Raupiano PP pipe with a wall thickness of 2.7-mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete

slab. The pipe was uncapped on both the unexposed and exposed ends. On the unexposed face, the annular gap between the pipe and slab was filled with a 5mm PE foam strip.

Penetration 3 H110S cast-in collar protecting a nominal 50mm PP pipe stack

The penetrating service comprised a 50-mm Raupiano PP pipe with a wall thickness of 1.8-mm fitted through the collar's sleeve. The pipe projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipe was supported at 300-mm from the unexposed face of the concrete slab. The pipe was uncapped on both the unexposed and exposed ends. On the unexposed face, the annular gap between the pipe and slab was sealed with non-shrink grout backfill and a 5mm PE foam strip was wrapped around the pipe.

Penetration 6 Two H110S cast-in collars each protecting a nominal 110mm HDPE pipe stack

The penetrating service comprised two 110-mm Terrain Fuze HDPE pipes with wall thicknesses of 4-mm fitted through the collar's sleeves. The pipes projected vertically 500-mm above the concrete and 500-mm into the furnace chamber. The pipes were supported at 300-mm from the unexposed face of the concrete slab. The pipes were uncapped on both the unexposed and exposed ends.

The results of these specimens are summarised in section A10.

A.9. Summary of CSIRO Test reports

Report #	Spec. #	Pipe Type	Pipe external ND (mm)	Annular gap (mm)	Wall thickness (mm)	Fitting	Backfill	Capping	Integrity/ Insulation (min.)
FSP 2050	1	PVC-SC	100	13.6	3.51	No	No	PVC End Cape	-/241NF/241NF
	2	HDPE	110	13.4	4.56	No	No	Supawool Plug	-/241NF/241NF
	3	PVC	40	47.6	2.1	No	Grout Backfill	PVC End Cape	-/241NF/241NF
	4	PVC	65	34.7	3	No	Grout Backfill	PVC End Cape	-/241NF/241NF
	5	PVC	80	28	3.1	No	Grout Backfill	PVC End Cape	-/241NF/241NF
FSP 2072	1	Triplus	110	10.3	3.7	Yes	No	Supawool Plug	-/241NF/241NF
	2	Raupiano	110	13.6	2.92	No	No	Raupiano Cape	-/241NF/241NF

A.10. Summary of BRE Test Reports

Report #	Spec. #	Pipe Type	Pipe ND (mm)	Annular gap (mm)	Wall Thickness (mm)	Fitting	Backfill	Capping	Integrity/ Insulation (min.)
P112838-1006	2	Blank	Blank	N/A	Blank	N/A	N/A	No	-/143 (flame) /143
P112838-1005	3	PVC	50	42	2	No	Grout Backfill	No	-/240NF/240NF
P112838-1000	3	PVC	50	38.9	5	Coupling	No	No	-/202NF/202 (slab)
P112838-1000	2	PVC	100	7	7	Coupling	No	No	-/202NF/202NF
P112838-1002	4	PVC	100	14	3.82	No	No	No	-/202(flame)/ 202(slab)
P112838-1002	6	PVC	100	14	3.4	No	Grout Backfill	No	-/239/218(slab)
P112838-1003	4	PVC	100 Manifold	14	100 pipe (3.5mm)	No	No	No	-/240NF/ 227 (slab)
P112838-1007	3	PP (Raupiano)	50	44	2.13	No	Grout Backfill + PE Foam Strip	No	-/226/226 (Integrity, affected by Spec. 6a)
P112838-1002	2	PP (Triplus)	50	41.7	2.33	Bell End	Grout Backfill	No	-/118/118 (Integrity affected by Spec. 1)
P112838-1002	3	PP (Triplus)	110	10.2	3.77	Bell End	No	No	-/240NF/234 (slab)
P112838-1007	2	PP (Raupiano)	110	14	3.25	No	5mm PE Foam strip	No	-/198(flame)/ 164(slab)
P112838-1000	4	HDPE	50	44	3.4	No	No	No	-/164(flame)/ 164
P112838-1000	6	HDPE	110	14	5	No	No	No	-/202NF/202NF
P112838-1007	6	2 x HDPE	2 x 110	14	4.47	No	No	No	-/223/175
P112838-1006	6	PE	50	44	5.36	No	Grout Backfill	No	-/222/222 (Integrity affected by Spec 4)
P112838-1006	3	PE	110	14	10.93	No	No	No	-/216(flame)/ 212

A.11. The relevance of referenced test data to AS 1530.4-2014

General

The fire resistance tests P112838-1000, P112838-1002, P112838-1003, P112838-1005, P112838-1006 and P112838-1007 were conducted in accordance with EN 1366-3: 2009 which follows the heating conditional and furnace atmosphere outlined in EN1363-1: 2012. This standard differs from AS 1530.4 2014 and the significance of these differences relevant to section 10 and is discussed below.

Temperature Regime

The furnace temperature regime for fire resistance tests conducted in accordance with AS 1530.4-2014 follows the same trend as EN 1363-1: 2012.

The parameters outlining the accuracy of control of the furnace temperature in AS 1530.4- 2014 and EN 1363-1: 2012 are not appreciably different.

Furnace Thermocouples

The furnace thermocouples specified in AS 1530.4-2014 are type K, mineral insulated metal sheathed (MIMS) with a stainless steel sheath having a wire of a diameter of not less than 1.0mm and an overall diameter of 3mm. The measuring junction protrudes at least 25mm from the supporting heat resistant tube.

The furnace thermocouples specified in EN 1363.1: 2012 (plate thermometers) are made from folded steel plate that faces the furnace chamber. A thermocouple is fixed to the side of the plate facing the specimen with the thermocouple hot junction protected by a pad of insulating material. The plate part is to be constructed from 150 ±1 mm long by 100 ±1 mm wide by 0.7 ±0.1 mm thick nickel alloy sheet strips.

The measuring junction is to consist of nickel-chromium/nickel aluminium (Type K) wire as defined in IEC 60584-1, contained within mineral insulation in a heat-resisting steel alloy sheath of nominal diameter 1 mm, the hot junctions being electrically insulated from the sheath.

The thermocouple hot junction is to be fixed to the geometric centre of the plate, by a small steel strip made from the same material as the plate. The steel strip can be welded to the plate or may be screwed facilitate the replacement of the thermocouple. The strip should be approximately 18 mm by 6 mm if it is spot-welded to the plate, and nominally 25 mm by 6 mm if it is to be screwed to the plate. The screw is to be 2 mm in diameter.

The assembly of plate and thermocouple should be fitted with a pad of inorganic insulation material 97 ±1 mm by 97 ±1 mm by 10 ±1 mm thick with a density of 280 ±30 kg/m3.

The relative location of the furnace thermocouples for the exposed face of the specimen, for AS 1530.4-2014 and EN 1363.1: 2012, is 100mm ±10mm and 100mm ±50mm respectively.

The furnace control thermocouples required by EN 1363.1: 2012 are less responsive than those specified by AS 1530.4-2014. This variation in sensitivity can produce a potentially more onerous heating condition for specimens tested to EN 1363.1: 2012, particularly when the furnace temperature is changing quickly in the early stages of a test.

Furnace Pressure

It is a requirement of AS 1530.4-2014 and for EN 1363-1: 2012 that for horizontal elements, a furnace gauge pressure of 20Pa is established at a height 100mm below the floor soffit level.

The parameters outlining the accuracy of control of the furnace pressure in AS 1530.4-2014 and EN 1363-1: 2012 are also not appreciably different.

Specimen Configuration

AS 1530.4-2014 specifies that the service(s) shall be installed so that they project a minimum 500mm on the exposed side of the supporting construction and for plastic pipes 2000mm on the non-exposed

side of which at least 200mm shall extend beyond the extremities of the penetration sealing system. The penetration sealing system shall include any coating, wrapping or other protections to the services.

EN 1366-3: 2009 specifies that a penetration shall be installed so that it projects a minimum of 500mm on each side of the support construction, of which at least 150mm shall extend beyond the extremities of protection seal. Also, it allows pipes to be tested in any of the configurations below to suit the final application.

In the referenced P112838-1000, P112838-1002, P112838-1003, P112838-1005, P112838-1006 and P112838-1007 reports, all of the pipes were tested uncapped on both sides of the wall, with 500mm extension of pipe on each side of the wall. In the referenced FSP 2050 and FSP 2072 reports, all of the pipes were capped on the furnace side with 500mm extension of pipe into the furnace and 2000mm extension of pipe outside the furnace. Generally, the longer pipe extension required by AS 1530.4-2014 increases the differential pressure across the collar for the duration of the test, particularly after a gap forms. Where there is sufficient evidence to correlate the performance of the plastic pipes and collars for a 500mm extension and 2000mm extension it is possible to confirm the 500mm is representative on a case by case basis.

Specimen thermocouples

The specimen thermocouple specification for service penetrations is generally the same for AS 1530.4-2014 and EN 1363.1: 2012 and EN 1366-3: 2009.

For the penetration construction considered, AS1530.4-2014 specifies the following locations for thermocouples to be placed:

- At not less than two points located approximately 25mm from the edge of the hole made for the passage of the service (one in the uppermost vertical plane).
- On the surface of the penetrating service, at least two thermocouples located approximately 25mm from the plane of the general surface of the penetrated element (one in the uppermost vertical plane).
- At least two positions 25 mm from the interface of the separating element and the main penetration seal.

For penetration sealing systems, EN 1363.1: 2012 specifies thermocouples are fixed in generally similar locations on the unexposed face: on the supporting construction and/or seal and on the penetrating service adjacent at the plane of penetration, and on the penetrating service some distance from the plane of penetration.

Based on the above, the effect of the differences on the thermocouple locations of the tested construction and the specifications in AS 1530.4-2014 is discussed on a case by case basis.

Criteria for failure

Specimens shall be deemed to have failed the integrity criterion in accordance with AS 1530.4-2014 when any of the following occur:

- sustained flaming for 10 seconds.
- a gap forms that allows the passage of hot gases to the unexposed face and ignite the cotton pad when applied for up to 30 seconds.
- a gap forms that allow the penetration of a 25mm gap gauge anywhere on the specimen.
- a gap forms that allow a 6mm × 150mm gap gauge to penetrate the specimen anywhere on the specimen.

Performance criteria in accordance with EN 1363 - 1: 2012:

Integrity: Failure, is deemed to occur:

a) when sustained flaming for not less than 10s on the unexposed face occurs;

b) when cracks, gaps or fissures allow flames or hot gases to cause flaming or glowing of a cotton fibre pad;
c) when a 6mm-diameter gap gauge can penetrate through a gap into the furnace and be moved in the gap for a distance of at least 150mm, or a 25mm- diameter gap gauge can penetrate through a gap into the furnace.

Insulation: Failure is deemed to occur:

a) when the temperature recorded at any position on the unexposed face is in excess of 180°C above the initial mean unexposed face temperature;
b) when integrity failure occurs.

The criteria for the referenced tests are not significantly different for tests undertaken in accordance with EN 1363-1: 2012 and Section 10 of AS 1530.4-2014.

Conclusion

The variations in furnace heating regimes, furnace thermocouples and the responses of the different thermocouple types to the furnace conditions are not expected to have a significant effect on the outcome of the referenced fire resistance test.

The differences in specimen configuration will affect the overall performance of the specimen. These differences are discussed below

The proposed construction shall be for pipes as tested in Table 1 and subject to the following variations;

- All pipes shall be capped on fireside and uncapped on non-fireside
- All pipes are to have 500mm on fireside and 2000mm pipe extension on non-fireside

Table 1 includes pipes which were tested in accordance with EN1366-3:2009, which resulted in the pipes been tested without capping on either side of the substrate and the extension of the pipes been less than the 2000mm required by AS 1530.4-2014.

AS 1530.4-2014 specifics for general application to pipe systems (e.g., SWV (soil waste vent), water supply and reticulation) the fireside capped/non-fire side open configuration shall be adopted.

With regards to the plastic pipes tested in P112838-1000, P112838-1002, P112838-1003, P112838-1005, P112838-1006 and P112838-1007, the pipe extensions on the non-fire side were 500mm away from the floors rather than 2000mm required by AS 1530.4-2014.

Theoretically, this difference in extension can affect the drawing of hot gases through the pipe by a 'stack effect' and can lead to high temperatures on the non-fire side of the specimen than for a shorter pipe extension.

The impact of the stack effect on the tested services can be significant when there are gaps at the penetrations and hot gases are passing in the pipes and in particular for floor specimens. The longer the length of the pipe above the collar is the greater the increase in pressure across the collar or gap. In another word, if gaps are present, the stack effect would render the pipe configuration in AS 1530.4 -2014 to be more onerous than that in EN1363-1: 2012.

The referenced tests FSP 2050 and FSP 2072 in accordance with AS 1530.4-2014 included pipes made from PVC-SC, HDPE, PVC, Triplus and Raupiano with a 500mm capped/2000mm uncapped configuration and protected with H110S collars. When these tests are compared with PVC, HDPE Triplus and Raupiano in accordance with EN 1366-3: 2009, it is confirmed for both test arrangements with the exception P112838-1000 specimen 4, the H110S collar activated around the 5-10 minutes mark.

For the constructions tested in P112838-1000, specimens 2, 3, 4 and 6 were tested uncapped on the exposed side and the unexposed side. Around 5 to 10 minutes, the H110S collars reacted and filled the aperture thereby reducing the smoke emissions. After this, aside from specimen 2, specimens 3, 4 and 6 did not vent volumes of smoke for up to 120 minutes. Specimen 2 displayed moderate amounts of

smoke from the top end and its pipe distorted sideways at 116 minutes. Aside from specimen 4, specimens 2,3 and 6 were able to maintain integrity for 202 minutes.

The significance of the above observation is that for P112838-1000 specimens 3, 4 and 6, minimal smoke emissions were recorded up to 120 minutes and as such the influence of the stack effect is also expected to be minimal. For specimen 2 which demonstrated an 82-minute margin of integrity over 120 minutes, even if it experienced an increase in differential pressure (stack effects) and associated accelerated degradation of the intumescent plug, it is considered there is sufficient confidence it will maintain integrity performance for at least 120 minutes when tested in accordance with AS 1530.4-2014.

For the constructions tested in P112838-1002, specimens 2, 3, 4 and 6 were tested uncapped on the exposed side and the unexposed side. Around 5 to 10 minutes, the H110S collars reacted and filled the aperture thereby reducing the smoke emissions. After this, specimens 2, 3, 4 and 6 did not vent volumes of smoke for up to 120 minutes. Aside from specimen 2 which caught fire at 118 minutes due to molten plastic from specimen 1, specimens 3, 4 and 6 were able to maintain integrity for at least 202 minutes.

The significance of the above observation is that the performance of P112838-1002 specimens 2, 3, 4 and 6 prior to the formation of gaps and smoke emission indicates that for the period up to 120 minutes, the influence of the stack effect would be minimal.

For the constructions tested in P112838-1003, specimen 3 was tested uncapped on the exposed side and the unexposed side. Around 2.5, the H110S collar reacted and filled the aperture thereby reducing the smoke emissions. After this, specimen 3 did not vent volumes of smoke for up to 120 minutes. Specimens 3 was able to maintain integrity for 151 minutes.

The significance of the above observation is that the performance of P112838-1003 specimen 3 prior to the formation of gaps and smoke emission indicates that for the period up to 120 minutes, the influence of the stack effect would be minimal.

For the constructions tested in P112838-1005, specimen 3 was tested uncapped on the exposed side and the unexposed side. Around 5 to 10 minutes, the H110S collars reacted and filled the aperture thereby reducing the smoke emissions. After this, specimen 3 did not vent volumes of smoke for up to 120 minutes. Specimens 3 was able to maintain integrity for 240 minutes.

The significance of the above observation is that the performance of P112838-1005 specimen 3 prior to the formation of gaps and smoke emission indicates that for the period up to 120 minutes, the influence of the stack effect would be minimal.

For the constructions tested in P112838-1006, specimens 3 and 6 were tested uncapped on the exposed side and the unexposed side. Around 10 to 15 minutes, the H110S collars reacted and filled the aperture thereby reducing the smoke emissions. After this, specimens 3 and 6 did not vent volumes of smoke for up to 120 minutes. Specimens 3 and 6 were able to maintain integrity for at least 216 minutes.

The significance of the above observation is that the performance of P112838-1006 specimens 3 and 6 prior to the formation of gaps and smoke emission indicates that for the period up to 120 minutes, the influence of the stack effect would be minimal.

For the constructions tested in P112838-1007, specimens 2 3 and 6 were tested uncapped on the exposed side and the unexposed side. Around 5 to 10 minutes, the H110S collars reacted and filled the aperture thereby reducing the smoke emissions. After this, specimens 2, 3 and 6 did not vent volumes of smoke for up to 120 minutes. Specimens 2, 3 and 6 were able to maintain integrity for at least 198 minutes.

The significance of the above observation is that the performance of P112838-1007 specimens 2, 3 and 6 prior to the formation of gaps and smoke emission indicates that for the period up to 120 minutes, the influence of the stack effect would be minimal.

Confidence in performance of the various pipe materials through H110S collar is demonstrated in FSP 2050 and FSP 2072 where PVC, HDPE, Triplus and Raupiano pipes of various size penetrated concrete labs and were protected with H110S collar. These pipes were tested in accordance with AS 1530.4 - 2014, and none of the pipes failed by integrity or insulation before 241 minutes.

It is evident that the specimens in FSP 2050 and FSP 2072 performed similarly or better than a similar pipe and collar constructions when tested to EN 1366-3:2009.

Based on the above discussion it is considered safe and reasonable in this particular case to apply the results of the referenced tests in accordance with EN1366-3:2009 to AS 1530.4-2014 up to 120 minutes integrity and insulation.

Based on the above discussion it is considered that the results relating to the integrity and insulation performance of the referenced EN1366-3:2009 tests are applicable up to 120 minutes when tested in accordance with AS 1530.4-2014 and when assessed in accordance with AS 4072.1 -2005.

Appendix B Analysis of Variations

B.1 Variation pipe size and materials

The proposed construction shall be for pipes as tested in Table 1 and subject to the following variations;

- The inclusion of AUS PVC & sandwich core PVC pipes as shown in Table 2.
- The inclusion of HDPE pipes, the pipes wall thickness and diameter may vary from max and min thickness as shown in Table 2
- The inclusion of Polypropylene pipes such as Valsir Triplus and Rehau Raupiano, the pipes wall thickness and diameter may vary from max and min thickness as shown in Table 2

The variations considered in this assessment are undertaken in accordance with Australian Standard AS 4072.1-2005 Components for the protection of openings in fire-resistant separating elements, Part 1: Service penetrations and control joints. This standard sets out the minimum requirements for the construction, installation and application of fire-resistance tests to sealing systems for service penetrations required to have a fire-resistance level.

AS 4072.1, clause 4.6 provides guidance on the application of the AS 1530.4 fire-resistance test data relating to plastic pipe penetrations. PVC-U DWV pipes and fittings for drain, waste and vent applications are covered under clause 4.6.3. Where a new pipe material is being assessed, this clause requires prequalification testing of nominated uPVC pipe sizes for the assessment of variation of pipe types other than uPVC DWV pipes.

This clause requires the prequalification testing of the following uPVC pipe sizes which are required to achieve the FRL:

- 40-mm
- 50-mm
- 65-mm
- 80-mm
- 100-mm

Further to this, Clause 4.6.4 of AS 4072.1 states that for pipes other than uPVC DWV, the maximum and minimum sizes are to be tested and must achieve the required FRL in the separating element. The OD of the largest pipe must not exceed 120-mm and the OD of the smallest pipe cannot be less than 40-mm.

This assessment is made reference to the requirements of this clause for the assessed pipes between 40mm and 110mm for pipes made from PVC, Sandwich Core PVC, HDPE, Polypropylene (Triplus), Polypropylene (Rehau Raupiano) and PE.

With reference to test data summaried in Section A9 and A10, various sizes and thicknesses plastic pipes made from AUS PVC, Sandwich Core PVC, HDPE, Polypropylene (Triplus), Polypropylene (Rehau Raupiano) and PE penetrated 150mm thick concrete slabs and were protected with a Snap H110S collar.

As discussed in Section A11, the test results relating to insulation and integrity in the reports P112838-1000, P112838-1002, P112838-1003, P112838-1005, P112838-1006 and P112838-1007 are applicable up to 120 minutes when tested in accordance with AS 1530.4-2014 and when assessed in accordance with AS 4072.1 -2005.

With reference to test data summaried in Section A9 and A10, it can be seen that the prequalification testing of the following uPVC pipe sizes have been met, and these pipes were able to maintain integrity and insulation performance of up to 120 minutes.

Also the proposed pipes made from PVC as well as material other than uPVC with their various wall thicknesses were tested and summariesd as per table A9 and A10. All of the pipes tested were able to maintain integrity and insulation performance of up to 120 minutes.

Based on the above, it can be expected the proposed pipe material and pipe wall thicknesses will achieve the FRL of at least -/120/120 if tested in accordance AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005.

B.2 Variation to penetration protections

The proposed construction shall be for pipes as tested in Table 1 and subject to the following variations;

- The collar may be filled with Rockwool in lieu of a pipe as tested in P112838-1006 Specimen 2.
- All pipes may be with and without fittings in the body of the fire collar.
- When the annular gap between the pipe and collar is less than 10mm, no backfilling is required.
- When the annular gap between the pipe and collar is 10mm but less than 20mm, a 10mm or deeper sealant shall be installed.
- When the annular gap is greater than 20mm, a 30mm or deeper grout backfill shall be installed.
- Collars may be clustered together for applications up to 120 minutes for 150mm slabs. 10 in a row up to two rows e.g. 2x1, 3x1…10x1 and2x2, 2x3, 2x4….. 2x10 in any combination of assessed pipe types shown in Table 1.

Collar Filling

The proposed construction comprises collar capped with Rockwool. With reference to Report P112838-1006 Specimen 2, the penetrating service comprised a disc of Rockwool to 50mm depth, bolted to an H110S plastic cap. The Rockwool was held in place with a vertical threaded rod, oversized washer on the base and nuts on the top and bottom. A dob of silicone sealant on the top unexposed nut. The Rockwool and cap were inserted into the top of the collar such that the cap was flush with the top of the. There was no pipe penetrating the collar. The specimen failed integrity and insulation at 143 minutes due to flaming.

Based on the above, the proposed construction will be able to maintain integrity and insulation for up to 120 minutes when tested in accordance with AS 1530.4 -2014 and assessed in accordance with AS 4072.1 -2005.

Pipe fitting within collar body

The proposed variation comprises pipes in Table 1 to be installed with and without fitting in the collar.

With reference to P112838-1000, specimen 3 comprised a 50mm x 3.7mm thick PVC pipe installed with 3.7mm thick coupling in an H110S collar resulting in a total wall thickness of 7.4mm in the collar. The specimen did not fail integrity nor insulation for up to 202 minutes.

With reference to P112838-1005, specimen 3 comprised a 50mm PVC pipe installed without coupling in an H110S collar resulting in a total wall thickness of 2mm in the collar. The specimen did not fail integrity nor insulation for up to 240 minutes.

Both specimens had the H110S collars closed around the 5-6 minutes mark, although P112838-1000, specimen 3 did fail insulation at 202 minutes.

With reference to P112838-1000, specimen 2 comprised a 100mm x 6.6mm thick PVC pipe installed with 6.6mm thick coupling in an H110S collar resulting in a total wall thickness of 13.2mm in the collar. The specimen did not fail integrity nor insulation for up to 202 minutes.

With reference to P112838-1002, specimen 4 comprised a 100mm PVC pipe installed without coupling in an H110S collar resulting in a total wall thickness of 3.2mm in the collar. The specimen did not fail integrity nor insulation for up to 202 minutes.

Both specimens had the H110S collars closed around the 7 minutes mark, although P112838-1002, specimen 4 did fail integrity at 202 minutes due to flaming.

The above tests showed that for up to 120 minutes, the presence or the absence of pipe fitting did not change the behaviour the collar pipe interaction. Both set up allowed the closure of the collar around the pipe to such an extent so that minimal furnace gas can pass through the pipe, allowing the pipe to maintain integrity and insulation for up to 120 minutes.

Based on the above, the proposed construction will be able to maintain integrity and insulation for up to 120 minutes when tested in accordance with AS 1530.4 -2014 and assessed in accordance with AS 4072.1 -2005.

Multiple collars

The proposed construction comprises H100s collars to be clustered together, with up to 10 collars in a row and up to two rows in any combination.

With reference to P112838-1007, specimen 6 comprised 2 HDPE pipes installed side by side with an H110S collar each. The specimen failed integrity at 223 minutes and insulation at 175 minutes on the concrete slab next to the penetration.

With reference to P112838-1000, specimen 6 comprised one HDPE pipe installed an H110S collar. The specimen did not fail integrity nor insulation for up to 202 minutes.

Both specimens demonstrated similar temperature curves on the pipe, which indicates that the clustered arrangement of the collar did not hinder the closure of the pipes. The clustered arrangement of the collars did allow the concrete around the collars to fail insulation faster than the slab around only one collar. This is expected due to the clustered collars reducing the amount of concrete present to soak up furnace heat. However, with 55 minutes margin on insulation, it is expected that the proposed cluster configuration will be able to maintain insulation for up to 120 minutes.

Based on the above, the proposed construction will be able to maintain integrity and insulation for up to 120 minutes when tested in accordance with AS 1530.4 -2014 and assessed in accordance with AS 4072.1 -2005.

Annular gap treatments

Gaps greater than 20mm

In the referenced tests summaries in Table A10, it is observed that with the exception of the 50mm HDPE pipe, the other 50mm pipes made from PP(Raupiano), PP(Triplus) and PE, and were backfilled with grout in its >20mm annular gap, all failed integrity due to flames or amber from other specimens. It is expected that without interference from other specimens, these 50mm pipes would have also maintained integrity for up to 240 minutes. With the difference in pipe extension requirements discussed in the section above it is expected that these pipes would be able to at least maintain integrity and insulation for up to 120 minutes when tested in accordance with AS 1530.4-2014.

For the 50mm HDPE pipe in P112838-1000 specimen 4, it is observed that it did not have grout backfill in its >20mm annular gap, which resulted in its earlier integrity failure. It is expected that with grout backfill, the 50mm HDPE pipe would also be able to maintain integrity and insulation for up to 120 minutes when tested in accordance with AS 1530.4-2014.

For the 50mm PVC pipe 100mm PVC pipe with coupling in P112838-1000 specimen 3, it is observed that it did not have grout backfill in its >20mm annular gap. The specimen did not fail integrity for 202 minutes duration of the test and failed insulation at 202 minutes. It is expected that with grout backfill, the 50mm PVC pipe would still be able to maintain integrity and insulation for up to 120 minutes when tested in accordance with AS 1530.4-2014.

Gaps greater than 10mm and less than 20mm

With reference to P112838-1002, specimen 4 comprised PVC pipe with its 14mm gap between the pipe and the collar not filled with anything. The specimen failed integrity and insulation at 202 minutes.

With reference to P112838-1002, specimen 3 comprised 110mm PP(Raupiano) pipe with a bell end connection, had its 10.2mm gap between the pipe and the collar not filled with anything. The specimen did not fail integrity for 240 minutes duration of the test and failed insulation at 234 minutes.

With reference to P112838-1007, specimen 2 comprised 110mm PP(Raupiano) pipe with its 14mm gap between the pipe and the collar filled with a 5mm PE foam strip. The specimen failed integrity at 196 minutes and insulation at 164 minutes.

With reference to P112838-1000, specimen 6 comprised 110mm HDPE pipe with its 14mm gap between the pipe and the collar not filled with anything. The specimen did not fail integrity nor insulation for 202 minutes.

With reference to P112838-1006, specimen 3 comprised 110mm PE pipe with its 14mm gap between the pipe and the collar not filled with anything. The specimen failed integrity at 216 minutes and insulation at 212 minutes.

It is observed in the results above, that PVC, HDPE, PP(Triplus) and PE pipes of 110mm dimension, had a gap between 10mm and 14mm while maintaining integrity for at least 196 minutes and insulation for 164 minutes. It is expected that filling the gap with a 10mm deep sealant, it will not detrimentally affect the integrity and insulation performance of the pipes for up to 120 minutes.

For the PP(Raupiano) pipe, it is expected that the 10mm sealant will function in the same manner as the 5mm PE foam strip in inhibiting hot gas from exiting the furnace via the annular gap. Therefore, expected that filling the gap with a 10mm deep sealant, the specimen will not detrimentally affect the integrity and insulation performance of the pipes for up to 120 minutes.

Gaps less than 10mm

As discussed above, that even without any filling, when gaps between the pipe of various materials were greater than 10mm but less than 20mm, the specimens were able to maintain integrity for at least 196 minutes and insulation for 164 minutes.

It is expected that when the gaps are smaller than 10mm, the collars will still be able to close off the pipes of various materials and allow them to maintain integrity and insulation for up to 120 minutes.

This confidence is demonstrated in the 100mm PVC pipe with coupling in P112838-1000 specimen 2. It is observed that it did not have any filling in its 7mm annular gap. The specimen did not fail integrity for 202 minutes duration of the test and failed insulation at 202 minutes.

Based on the above, it is expected that the proposed construction will be able to maintain integrity and insulation for up to 120 minutes when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1 -2005.

B.3 Variation to the pipe wall thickness

The proposed construction shall be for pipes as tested in Table 1 and subject to the following variations;

- Variation to pipe wall thickness to that shown in Table 2.

Table B1 – Proposed Pipe wall thickness

Pipe material	Nominal size (mm)	Wall thickness (mm)
HDPE	50	3
	56	3
	63	3
	75	3
	90	3.5
	110	4.3
PE	50	4.6
	63	5.8
	75	6.8
	90	8.2
	110	10
Triplus PP	50	2.3
	75	2.6
	90	3.1
	110	3.7
Raupiano PP	50	2.1
	75	2.4
	110	2.9

With reference to discussions in Section B1, it is shown that the prequalification testing of uPVC pipes was carried out. Further to this, Clause 4.6.4 of AS 4072.1 states that for pipes other than uPVC DWV, the maximum and minimum sizes are to be tested and must achieve the required FRL in the separating element. The OD of the largest pipe must not exceed 120-mm and the OD of the smallest pipe cannot be less than 40-mm.

This assessment is referred to the requirements of this clause for the assessed pipes between 40mm and 110mm for pipes made from HDPE, Polypropylene (Triplus), Polypropylene (Rehau Raupiano) and PE.

Table B2 – Tested Pipe wall thickness

Report	Specimen No.	Pipe Material	Diameter (mm)	Wall thickness (mm)	-/Integrity/Insulation (minutes)
P112838-1000	4	HDPE	50	3.4	-/164(flame)/ 164
FSP 2050	2	HDPE	110	4.56	-/241NF/241NF
P112838-1006	6	PE	50	5.36	-/222/222 (Integrity affected by Spec 4)
P112838-1006	3	PE	110	10.93	-/216(flame)/ 212
P112838-1002	2	Triplus	50	2.33	-/118/118 (Integrity affected by Spec. 1)
FSP 2072	1	Triplus	110	3.7	-/241NF/241NF
P112838-1007	3	Raupiano	50	2.13	-/226/226 (Integrity, affected by Spec. 6a)
FSP 2072	2	Raupiano	110	2.92	-/241NF/241NF

With reference to table B1, the maximum 110mm and minimum 50mm sizes of plastic pipes made from HDPE, Polypropylene (Triplus), Polypropylene (Rehau Raupiano) and PE penetrated 150mm thick concrete slabs and were protected with a Snap H110S collar.

For the proposed HDPE and PE pipes, the proposed pipe diameters are within the tested maximum and minimum diameter. The ratio of the pipe diameter to wall thicknesses is also generally within the tested range. The only exception is the 50mm diameter pipes for these pipe materials which are 12 - 15% thinner than the smallest pipe diameter tested.

Upon consideration of the 44 to 102 minutes margin on integrity for the 50mm diameter HDPE and PE pipes respectively, it is considered that the slightly thinner 50mm pipe will also be able to maintain integrity for up to 120 minutes.

For the proposed Triplus pipes, the proposed pipe diameters are within the tested maximum and minimum diameter. The ratio of the pipe diameter to wall thicknesses is also generally within the tested range. The only exception is the 50mm diameter pipe for this material which is 2% thinner than the smallest pipe diameter tested.

P112838-1002 specimen 2, which comprised 50mm diameter Triplus pipe, caught fire at 118 minutes due to molten plastic from specimen 1 with no signs of impending integrity failure for up to 120 minutes. It is expected that this specimen would have maintained integrity for at least 120 minutes if it was not interrupted by specimen 1.

It is considered that the 2% reduction in pipe wall thickness will not detrimentally affect the integrity performance of P112838-1002 specimen 2 for up to 120 minutes.

For the proposed Raupiano pipes, the proposed pipe diameters are within the tested maximum and minimum diameter. The ratio of the pipe diameter to wall thicknesses is also generally within the tested range. The only exception is the 50mm diameter pipe for this pipe material which is 2% thinner than the smallest pipe diameter tested.

Upon consideration of the 106 minutes margin on integrity for the 50mm diameter Raupiano pipe, it is considered that the slightly thinner 50mm pipe will also be able to maintain integrity for up to 120 minutes.

Based on the above, having satisfied both Clause 4.6.4 of AS 4072.1, it is considered the proposed pipe sizes and wall thicknesses in Table 2 will maintain integrity and insulation for up to 120 minutes when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1 -2005.

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