Fire resistance of various SNAP 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 various SNAP fire collar 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 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
FP4640	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FP4837	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FR5670	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1564	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1575	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1576	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1577	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1592	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1615	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1686	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1696	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1700	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1735	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1736	AS 1530.4 -2005	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1830	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP1875	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 120 mm thick concrete slab.
FSP1857	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 120 mm thick concrete slab.
FSP1882	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 120 mm thick concrete with steel permanent formwork slab.
FSP1883	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 120 mm thick concrete with steel permanent formwork slab.
FSP1986	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.
FSP2002	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 120 mm thick concrete slab.
FSP2008	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 120 mm thick concrete slab.
FSP2016	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 120 mm thick concrete slab.
FSP2028	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 120 mm thick concrete slab.
FSP2116	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 120 mm thick concrete slab.
FSP2177	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 120 mm thick concrete slab.

Report Reference	Test Standard	Outline of Test Specimen
FSP2090	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 116mm thick plasterboard lined wall.
FSP1902	AS 1530.4 -2014	A fire resistance test of pipe penetrations in a 150 mm thick concrete slab.

The referenced tests FP4640, FP4837 and FR5670 were tested at Branz, NZ and sponsored by Snap Fire Systems. The referenced tests FSP1564, FSP1575, FSP1576, FSP1577, FSP1592, FSP1615, FSP1686, FSP1696, FSP1700, FSP1735, FSP1736 were tested at CSIRO and sponsored by Snap Fire Systems. The referenced tests FSP1830, FSP1882, FSP1883, FSP1986, FSP2002, FSP2008, FSP2016, FSP2028, FSP2116, FSP2177, FSP2090, FSP1902 were tested at CSIRO and sponsored by IG 6 Pty Ltd. The referenced tests FSP1875 and FSP1857 were tested at CSIRO and sponsored by Combat Collars Pty Ltd and these reports are owned by IG 6 Pty Ltd.

3 Proposed Variations

3.1 SNAP Cast-In collars

The proposed construction shall be Snap collars tested in Table 1 and listed in Tables 2-4, and subject to the following variations:

- The inclusion of SNAP collars as shown in Figures 1-7
- The inclusion of a low top version of the H100S-RR collar – L100S
- The inclusion of plastic pipes as shown in Tables 2 - 4
- All cast-in collars to be grout backfilled between collar and support construction
- Plastic pipes to be supported above the slab and each side of the wall
- Floor grate to be either chromed brass floor grate or ABS floor grate
- H100FSW-RR collars to require a minimum of 15mm screed coverage in 120mm slabs and 35mm screed coverage in 150mm -175mm slabs
- The inclusion of pipe fitting/coupling as same wall thickness as pipe, for pipes, as shown in Tables 2 - 4
- Cast-in collars can be trimmed as per Figures 8 and 9
- When the annular gap between the pipe and collar is less than 10mm, no sealant or backfilling is required.
- When the annular gap between the pipe and collar is 10mm but less than 15mm, a 10mm or deeper Fuller Firesound with PE foam backing rod.
- When the annular gap between the pipe and collar is 15mm but less than 20mm, the gap shall be grout backfill to a minimum depth of 30mm.
- The inclusion of 120mm, 150mm and 175mm thick concrete with steel permanent formwork slab as a separating element
- Steel permanent formwork modified to ensure 40mm grout backfill coverage around fire collar active area where required as per 13a
- The inclusion of active area of the collar less than 40mm from formwork rib as per Figure 13b

3.2 SNAP Retrofit collars

The proposed construction shall be Snap collars tested in Table 1 and listed in Table 5, and subject to the following variations:

- The inclusion of SNAP collars as shown in Figure 14
- The inclusion of pipe as shown in Table 5
- Plastic pipes to be supported above the slab and each side of the wall.
- The inclusion of minimum 116mm thick plasterboard lined walls, minimum 120mm thick concrete wall or block wall and minimum 150mm thick concrete slab as a support construction.
- For slabs, when the annular gap between the pipe and collar is to be less than 5mm to be sealed with a bead of Fuller Firesound sealant
- Fixings for retrofit collars shall be as per Table 6b

Table 2: Concrete slab/Steel permanent formwork slab with SNAP stack collars

Collar	Support construction thickness (X)	Pipe material	Pipe Nominal Diameter (mm)	Pipe thickness	Pipe fitting within the collar
H100S-RR/ L100S	Minimum 120mm concrete or steel permanent formwork slab	U-PVC	50	2-2.3	No
			65	2.9	Yes
			80	3	Yes
		PVC (SC)	100	3.1-3.26	Yes
	Minimum 150mm concrete or concrete with steel permanent formwork slab	HDPE	63	3.7	No
H65S-RR			40	3.3	No
			56	3.5	No
			63	3.7	No

Table 3: Concrete slab/concrete with steel permanent formwork slab with SNAP floor waste collars

Collar	Support construction thickness (X)	Pipe material	Pipe Nominal Diameter (mm)	Pipe thickness	Pipe fitting within the collar
H100FWS-RR/ L100FWS	Minimum 120mm concrete slab with a minimum 15mm screed or Minimum 120mm concrete with steel permanent formwork slab with a minimum 15mm screed or Minimum 150mm concrete slab with a minimum 35mm screed or Minimum 150mm concrete with steel permanent formwork slab with a minimum 35mm screed	U-PVC	50	2.4	No
			65	2.7	No
			80	2.9	No
		PVC (SC)	100	3.1-3.5	Yes
		HDPE	110	4.7	No

Table 4: Concrete slab/concrete with steel permanent formwork slab with SNAP combat collars with stack collars

Collar	Support construction thickness (X)	Pipe material	Pipe Nominal Diameter (mm)	Pipe thickness	Pipe fitting within the collar
CC 40	Minimum 120mm concrete or concrete with steel permanent formwork slab	U-PVC	40	2	Yes
CC 50			50	2.3	Yes
CC 100		U-PVC SC	100	3.3	Yes
CC 40		HDPE	40	3.5	No
CC 50			50	3.1-3.5	No
CC 100			110	5	No

Table 5: SNAP 65-80R collar with PVC pressure pipes in walls and floors

Collar	Support construction thickness (X)	Pipe material	Pipe Nominal Diameter (mm)	Pipe thickness	Pipe fitting within the collar
SNAP 65-80R collar	Min. 116mm thick plasterboard lined Or Minimum 120mm concrete or masonry wall	PVC-U, PVC-O or PVC-M pressure pipes (PN12)	65	4	No
			80	5	No
	Minimum 150mm Concrete slab		65	4	No
			80	5	No

Table 6a: Gap treatment between the cast-in collar and plastic pipe

The gap between collar and pipe on the unexposed side of the slab	Gap treatment
<10mm	No sealant or grout
10-15mm	10mm or deeper Fuller Firesound sealant and PE foam backing rod
15-20mm	Fully backfilled with grout

Table 6b: Collar fixings for retrofit collars

Separating Element	Fixing (minimum size)	
13mm and 16mm Plasterboard lined wall	M4 Expandable steel anchors	
Concrete or Masonry Wall or a Concrete slab	5mm x 30mm concrete screw bolts	
	5mm x 30mm steel mushroom head spikes	
	6.5 x 40mm steel sleeve anchors	
	6 x 35mm steel wedge anchors	

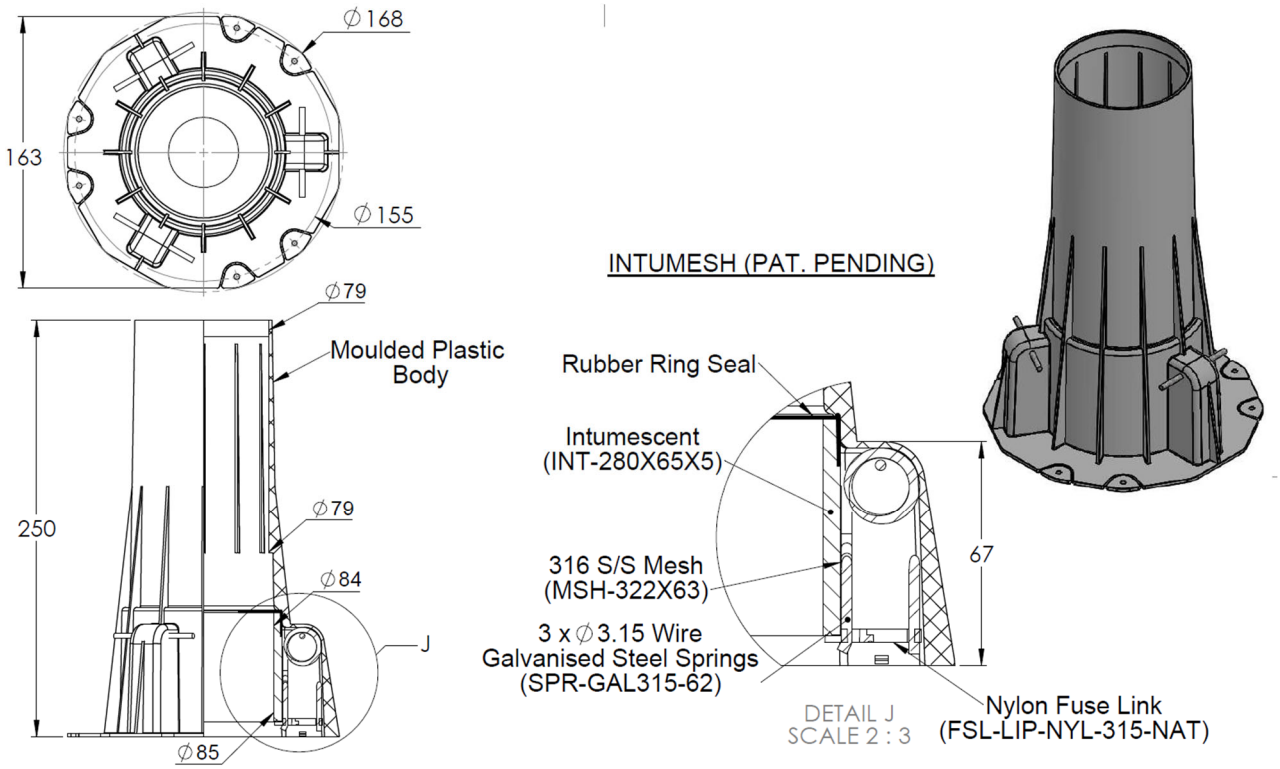

Figure 1: SNAP H65S-RR collar

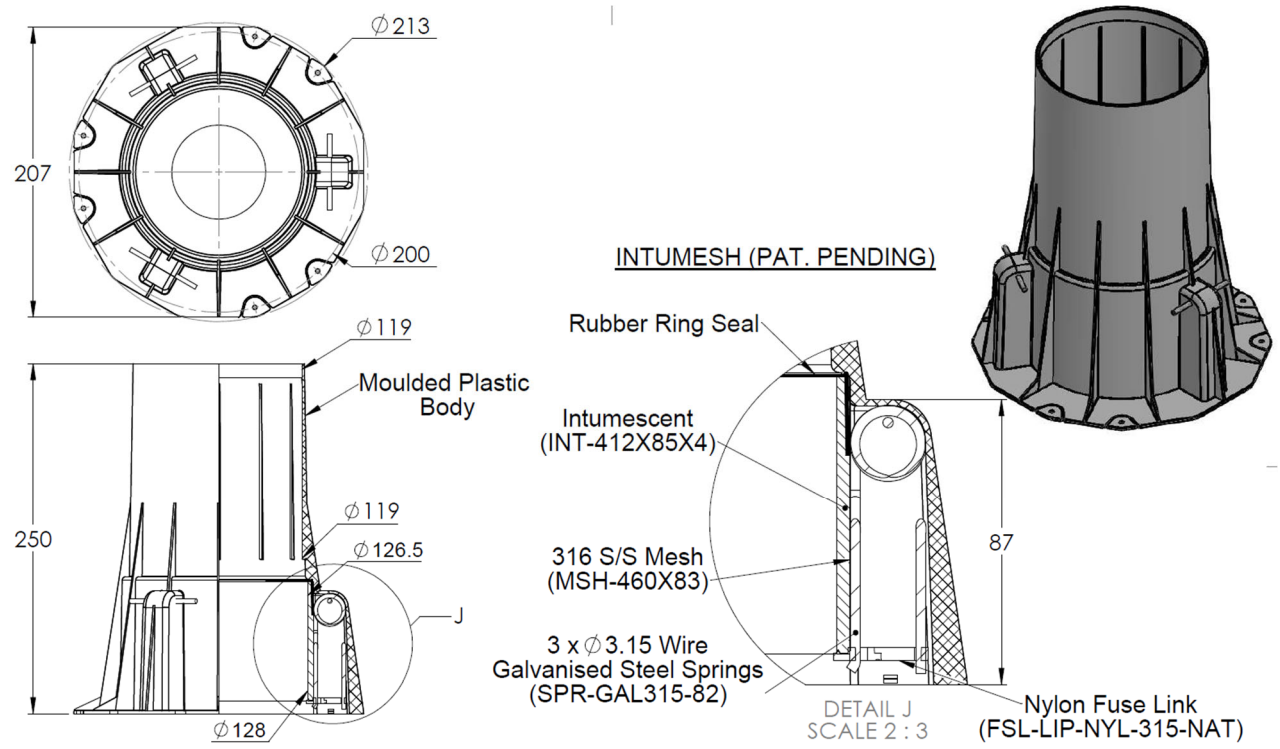

Figure 2: SNAP H100S-RR collar

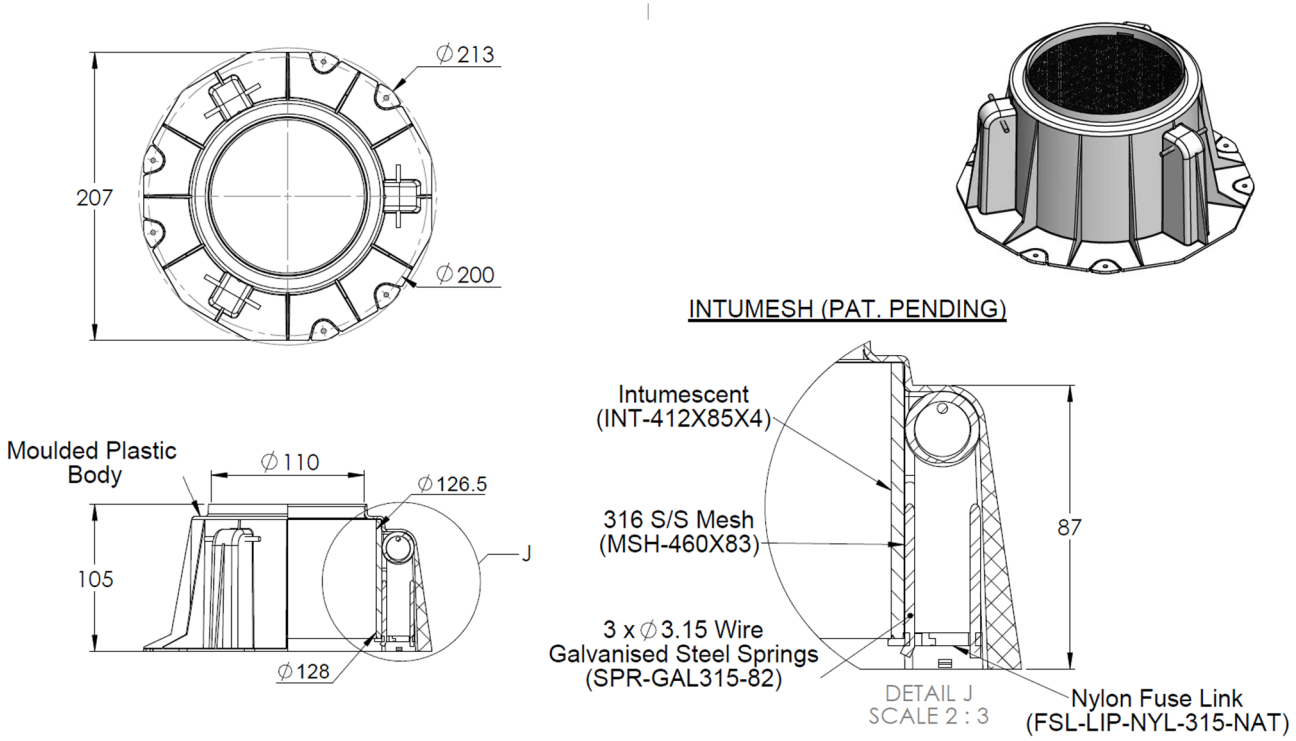

Figure 3: SNAP L100S collar

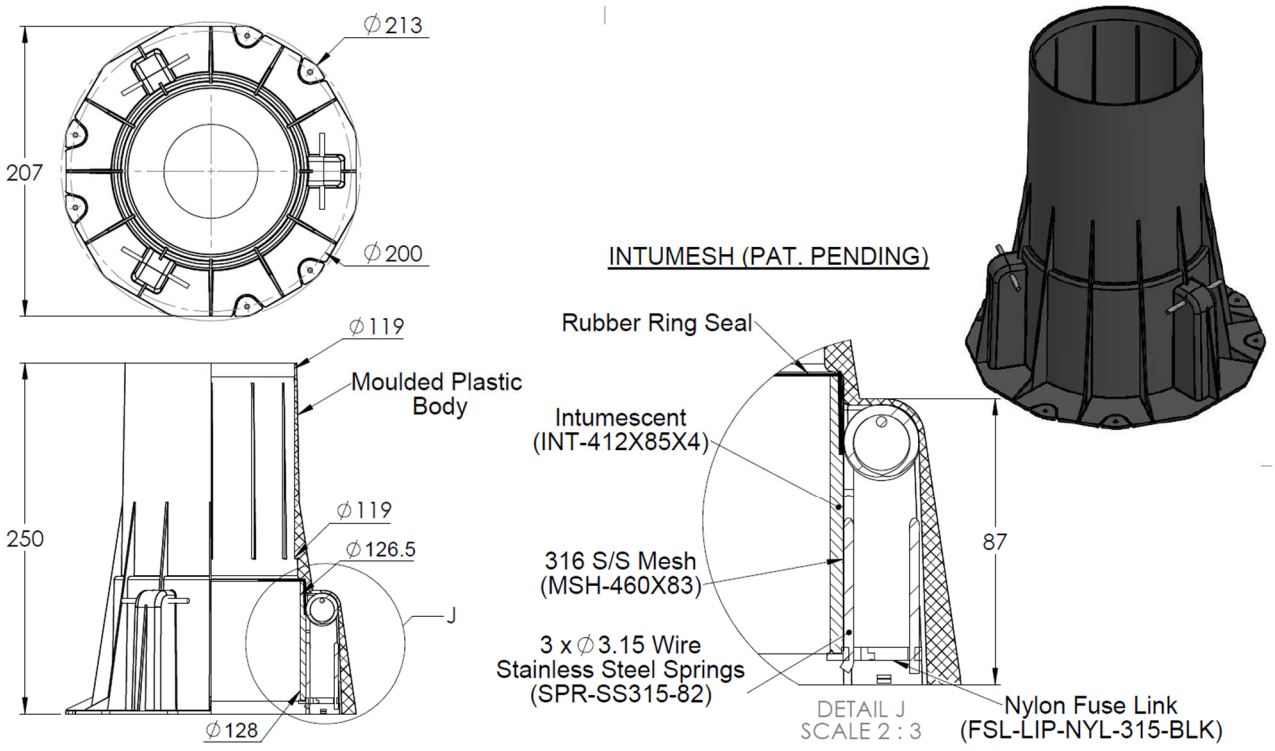

Figure 4: SNAP H100FWS-RR collar

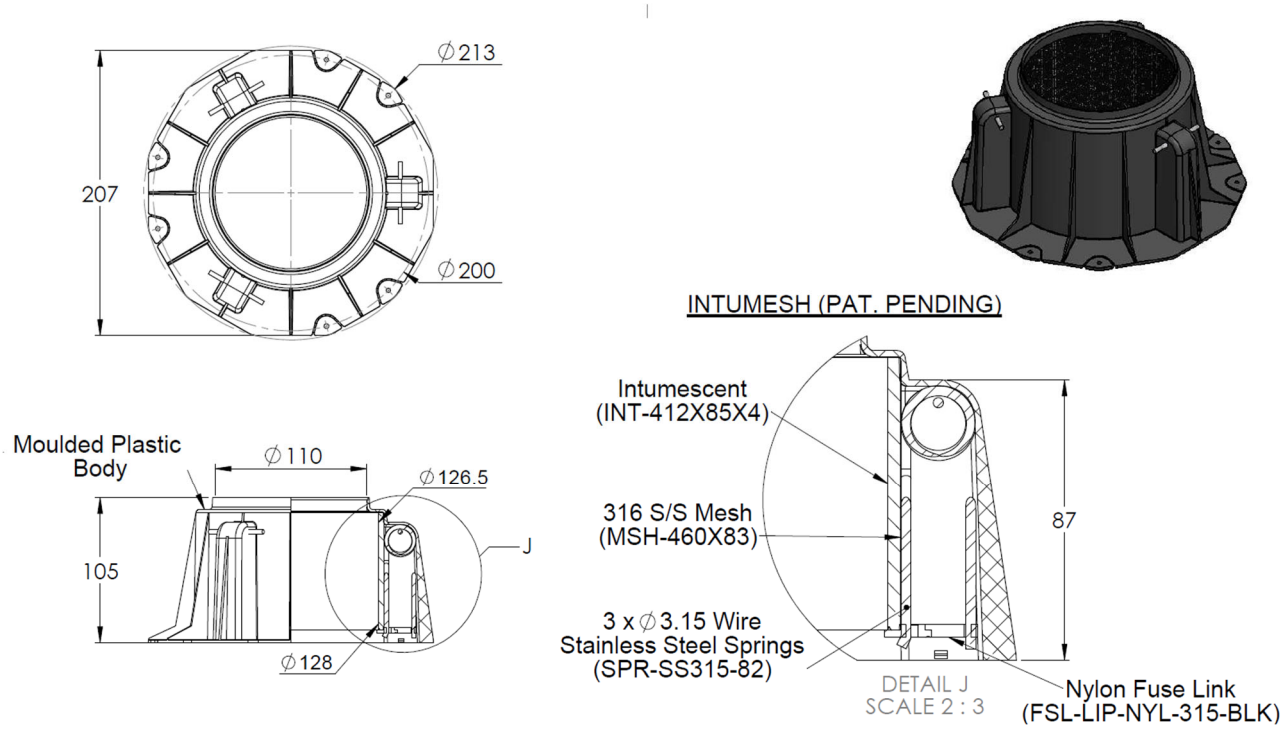

Figure 5: SNAP L100FWS collar

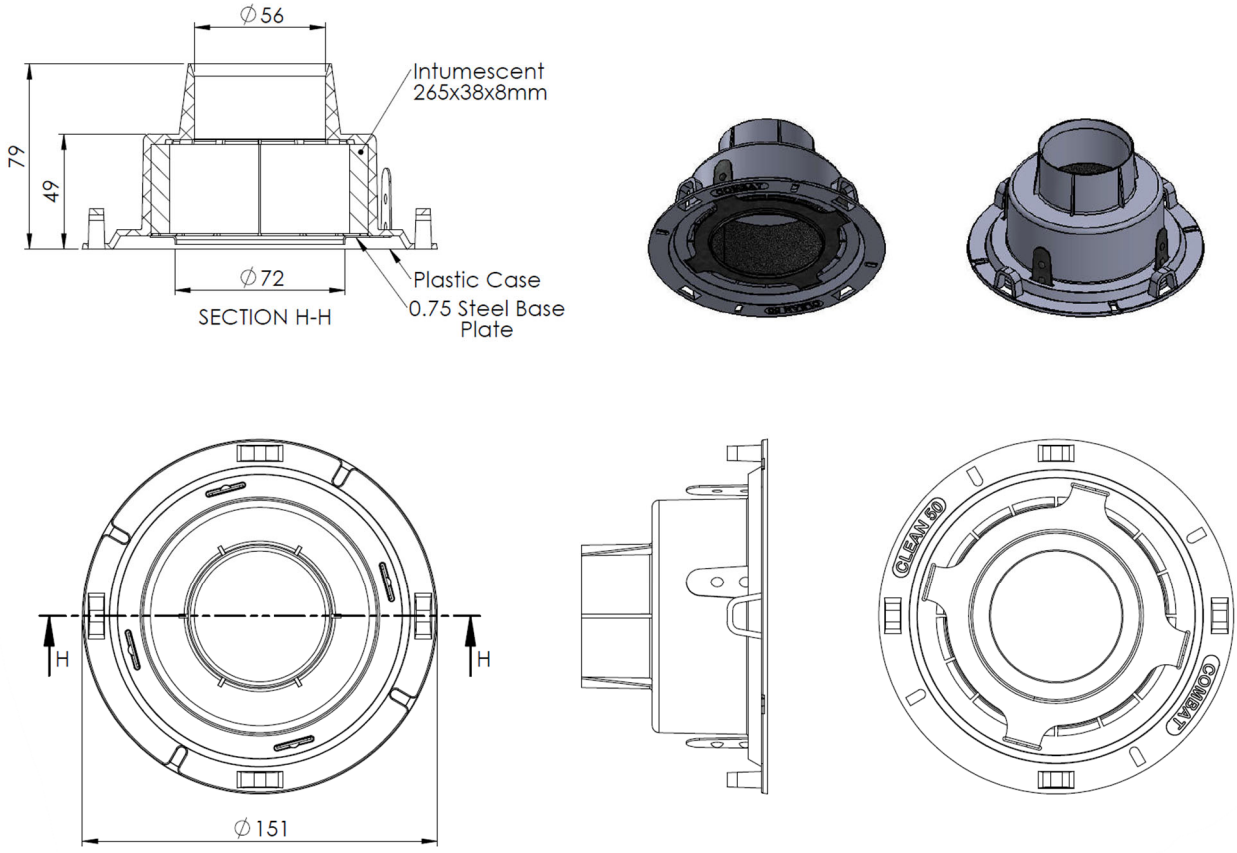

Figure 6: SNAP CC-50 collar

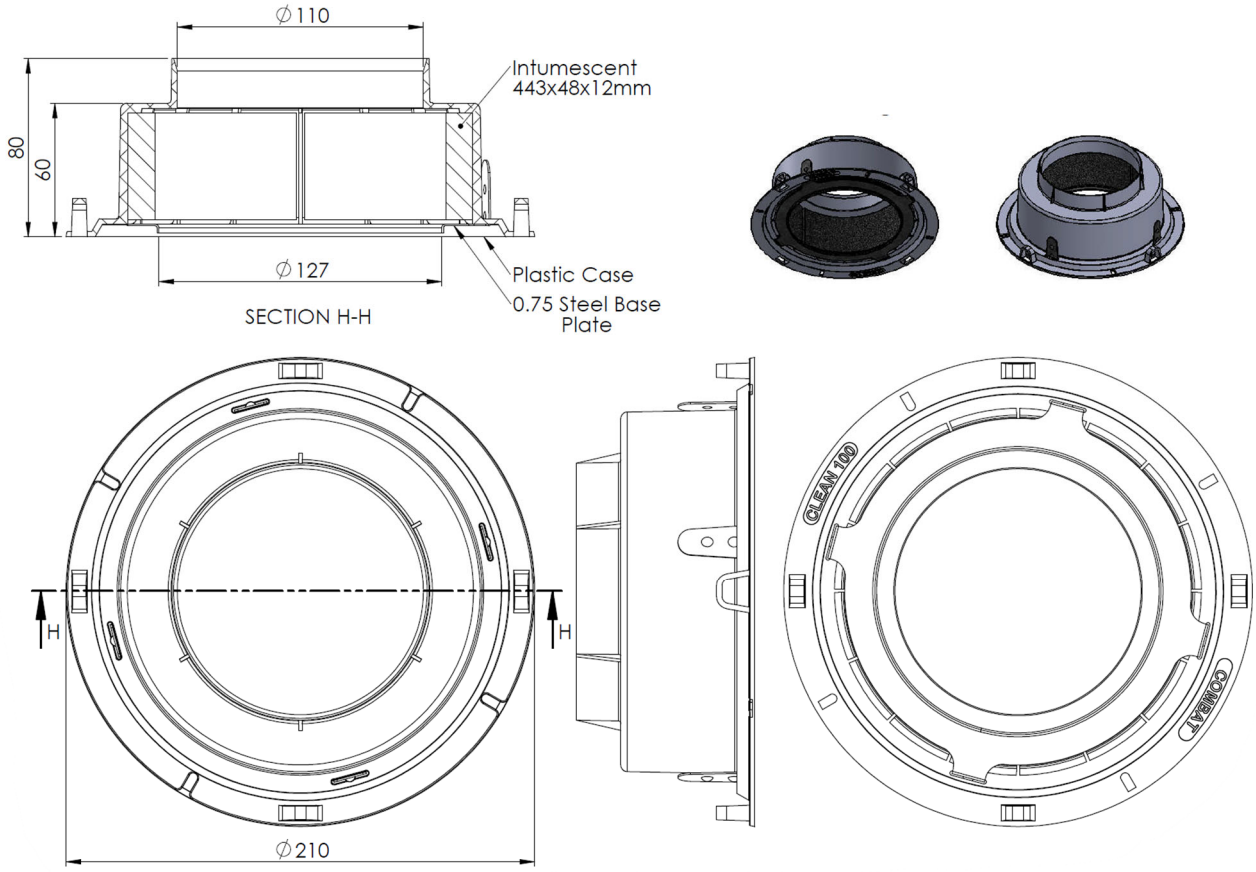

Figure 7: SNAP CC-100 collar

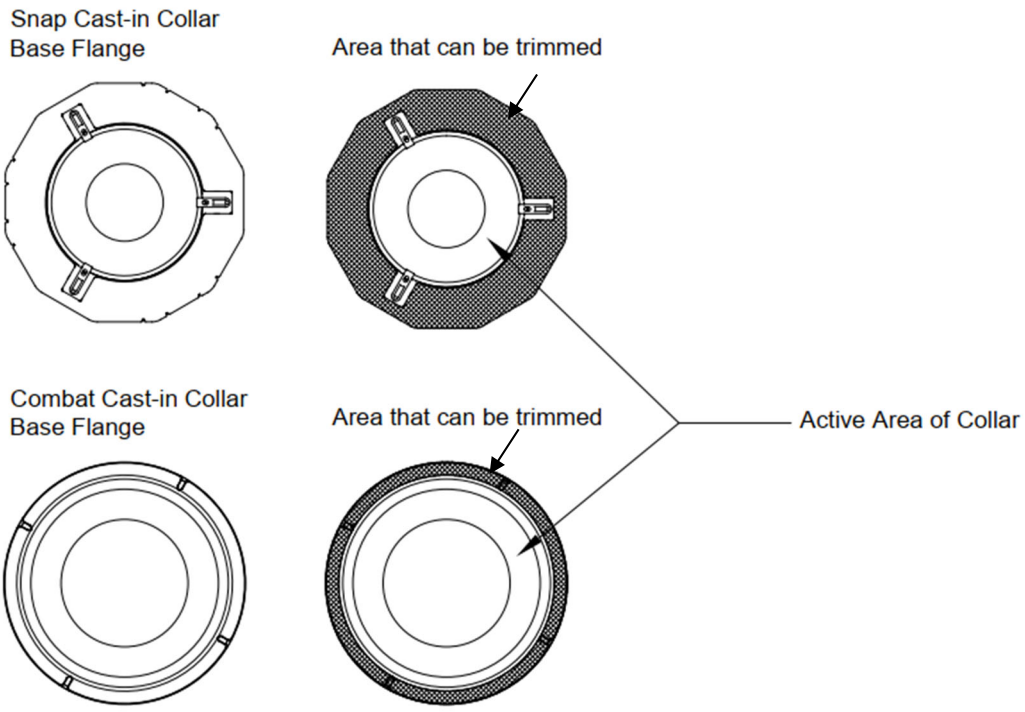

Figure 8: Definition of areas than can be trimmed

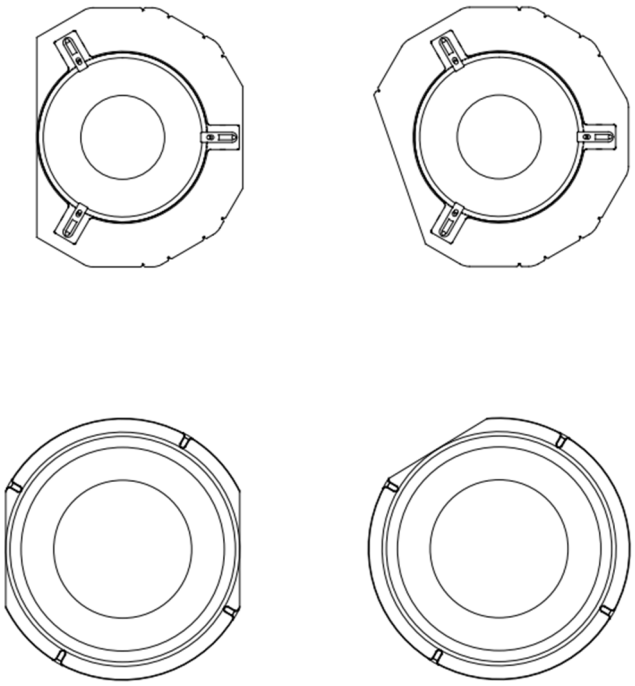

Figure 9: Examples of the extent of flange Trimming – No trimming of spring pockets permitted

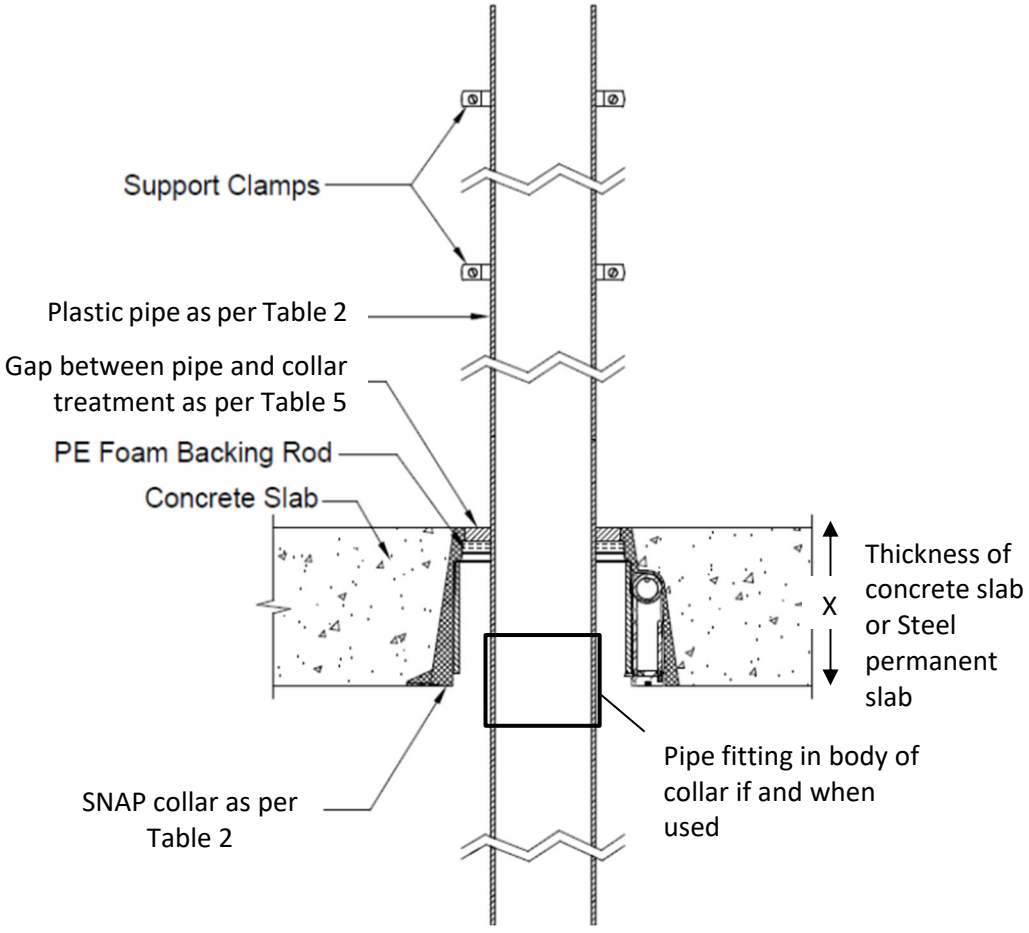

Figure 10: Example of installation of SNAP H100S-RR collars with stack pipes in concrete slab/concrete with steel permanent formwork slab

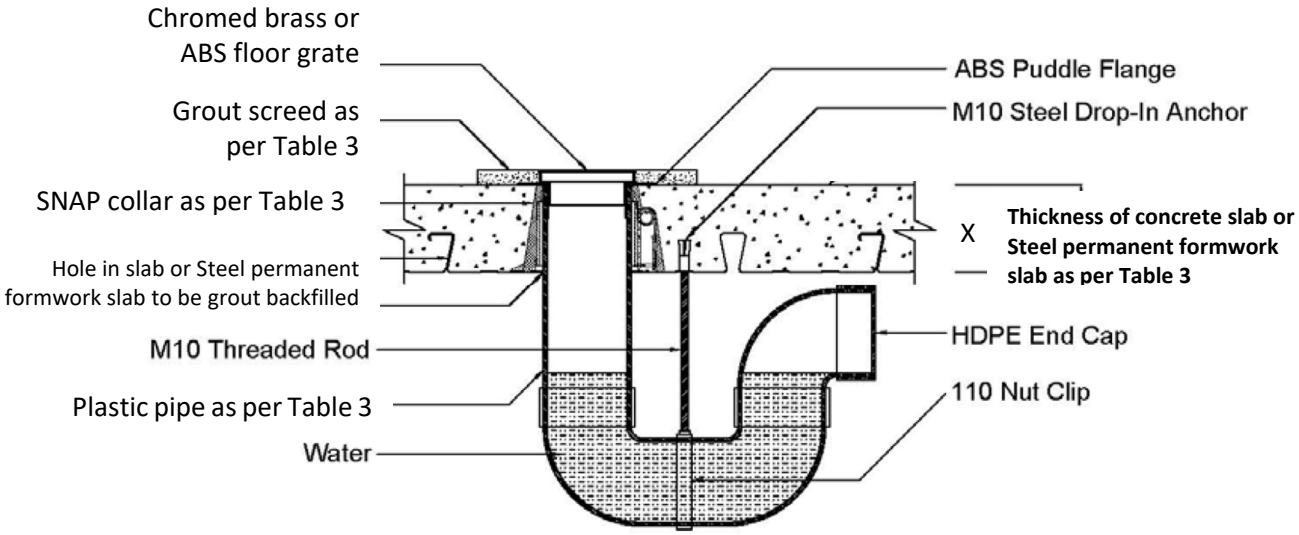

Figure 11: Example of installation of SNAP H100FWS-RR collars with floor waste pipes in concrete slab/concrete with steel permanent formwork slab

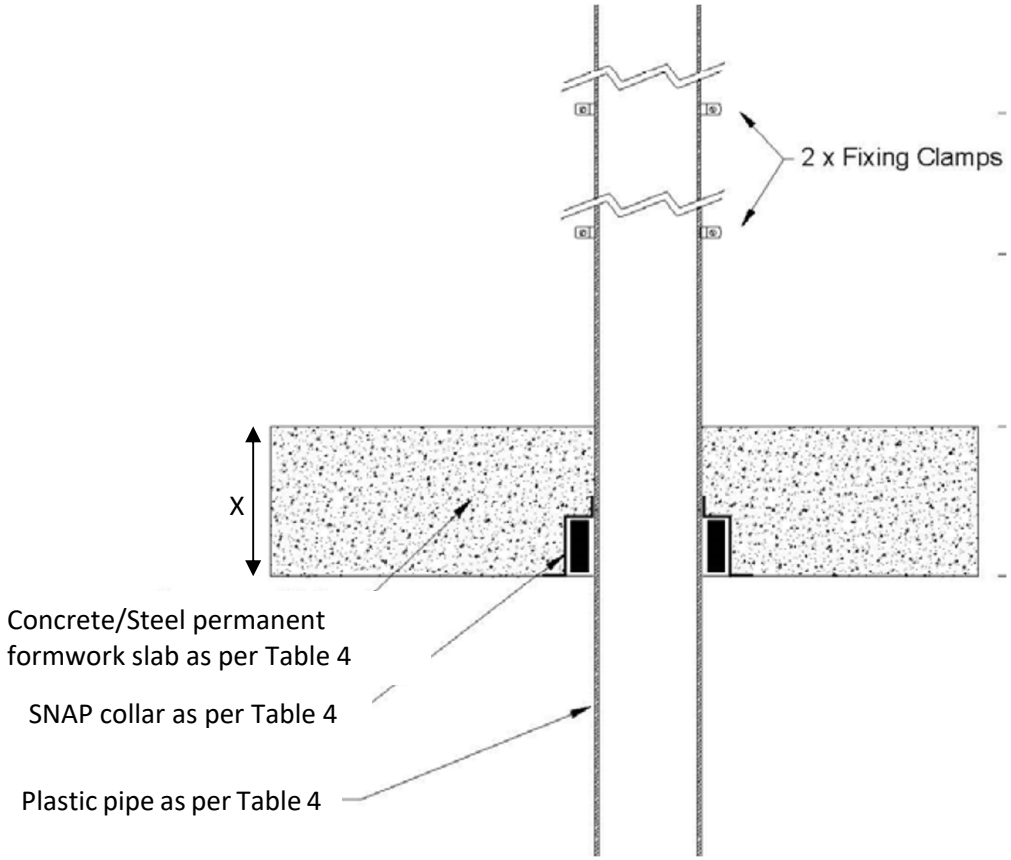

Figure 12: Installation of SNAP Combat collars with stack pipes in concrete slab or concrete with steel permanent formwork slab

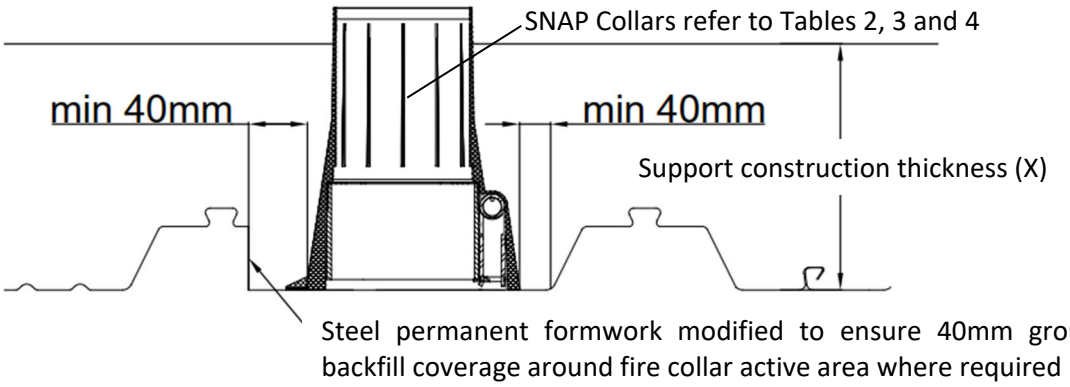

Figure 13a: An example of the installation of SNAP collars in concrete with steel permanent formwork slab – active area of the collar ≥40mm from edge of rib

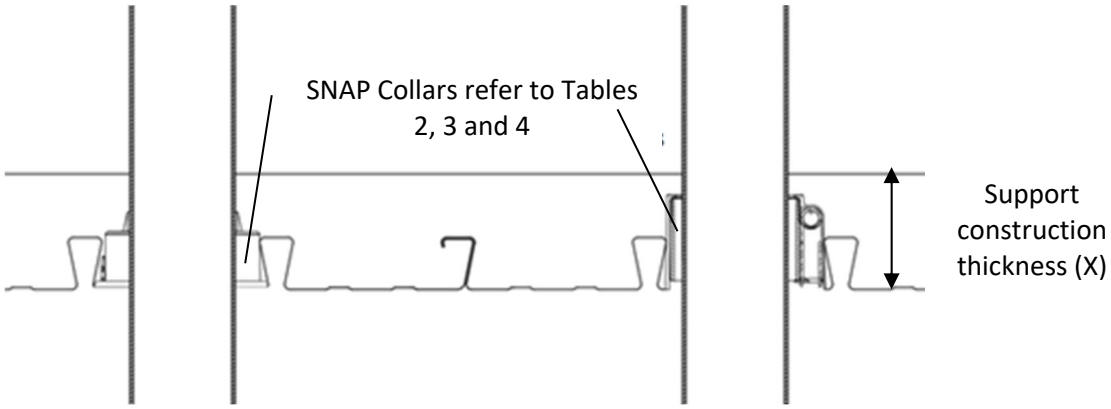

Figure 13b: An example of the installation of SNAP collars in concrete with steel permanent formwork slab – active area of the collar < 40mm from edge of rib. For this installation it is required the structural adequacy of the steel permanent formwork be verified by others. Refer to Section 7 of this report.

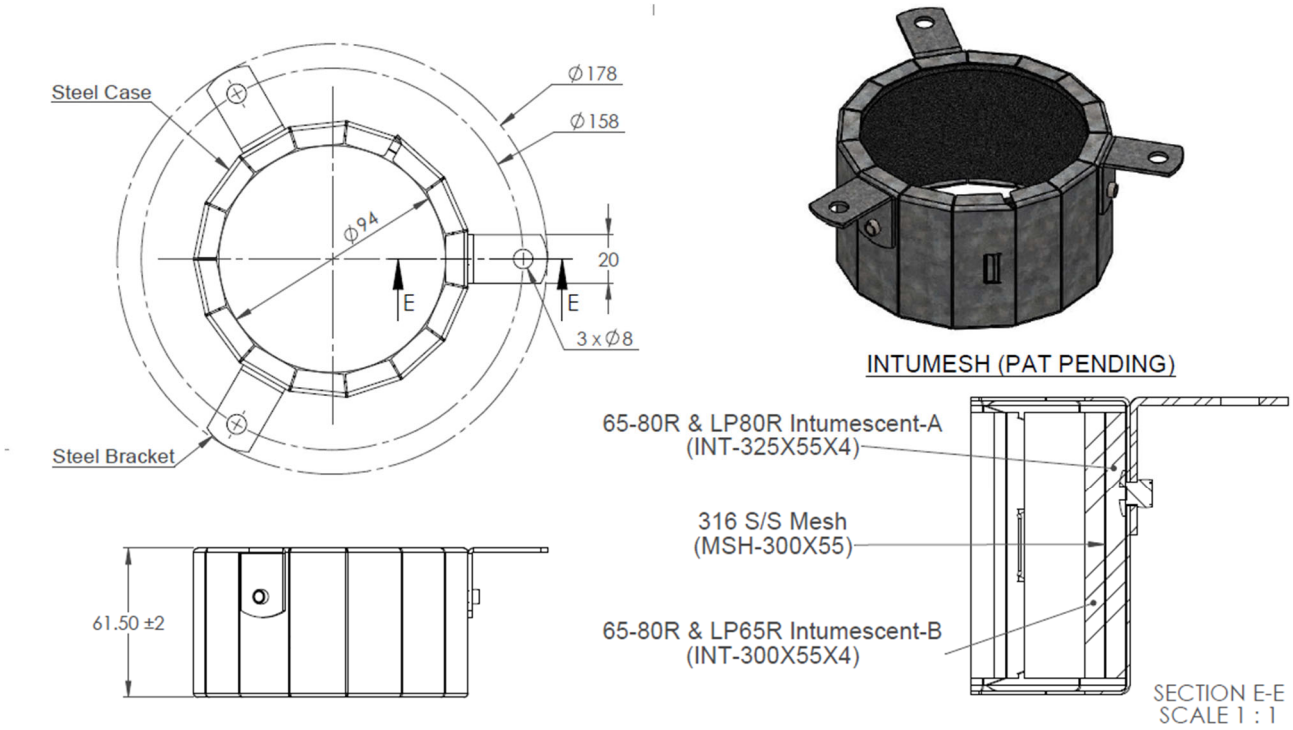

Figure 14: SNAP 65-80R collar

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. Section 10 as appropriate for service penetrations.

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 7: Stack pipe through concrete slab/concrete with steel permanent formwork slab

SNAP Collars	Pipe material	Pipe Nominal Diameter (mm)	Fitting within the body of the collar	Figures and Tables	FRL		
					Support construction thickness (X) (excluding screed)		
					≥120mm	≥150mm	≥175mm
H100S-RR/ L100S	U-PVC	50	No	Figures 1, 2, 3, 8, 9, 10, 13a, 13b and Tables 2 and 6	-/120/120	-/180/180	-/240/240
		65	Yes		-		
			No		-/120/120		
		80	Yes		-		
			No		-/120/120		
	U-PVC (SC)	100	Yes				
			No				
	HDPE	63	No		-	-/180/180	-/240/240
H65S-RR		40	No				
		56	No				
		63	No				

Table 8: Floor waste through concrete slab/concrete with steel permanent formwork slab

SNAP Collars	Pipe material	Pipe Nominal Diameter (mm)	Fitting within the body of the collar	Figures and Tables	FRL		
					Support construction thickness (X) (excluding screed)		
					≥120mm	≥150mm	≥175mm
H100FWS-RR/ L100FWS	U-PVC	50	No	Figures 4, 5, 8, 9, 11, 13a, 13b and Table 3	-/120/120	-/180/180	-/240/240
		65	No				
		80	No				
	U-PVC (SC)	100	No				
			Yes		-		
	HDPE	110	No		-/120/120	-/180/180	-/240/240

Table 9: SNAP CC collar with stack pipes through concrete slab/concrete with steel permanent formwork slab

SNAP collars	Pipe material	Pipe Nominal Diameter (mm)	Fitting within the body of the collar	Figures and Tables	FRL		
					Support construction thickness (X) (excluding screed)		
					≥120mm	≥150mm	≥175mm
CC 40	U-PVC	40	Yes	Figures 6, 7, 8, 9, 12, 13a, 13b and Table 4	-/120/120	-/180/180	-/240/240
			No				
CC 50		50	Yes				
			No				
CC 100	U-PVC (SC)	100	Yes				
			No				
CC 40	HDPE	40	No				
CC 50		50	No				
CC 100		110	No				

Table 9: SNAP 65-80R collar with PVC pressure pipes in walls and stack pipe through floors

SNAP Collars	Support construction thickness (X)	Pipe material	Pipe Nominal Diameter (mm)	Fitting within the body of the collar	Figures and Tables	FRL	
SNAP 65-80R collar each side of the wall	≥ 116mm thick plasterboard lined wall with a tested or assessed FRL of -/120/120 Or ≥ 120mm Concrete or block wall	PVC-U, PVC-O or PVC-M pressure pipe (PN12)	65	No	Figures 14 Table 6a	-/120/120	-/120/120
			80	No			
SNAP 65-80R collar under side of floor	≥150mm Concrete slab		65	No			
			80	No			

6 Direct Field of Application of Results

The results of this report are applicable to floors when exposed to fire from below and for walls when exposed to fire from either side.

7 Requirements

Where concrete slabs, concrete with steel permanent formwork slab, blockwork and plasterboard walls are specified in this report, it is required that they be designed, tested or assessed as a separating element for the required FRL of the service penetration specified in Section 5.

For concrete with steel permanent formwork slabs where the collar less than 40mm from the parts of the steel permanent formwork carrying load in the fire load case such as figure 13b, the structural adequacy of the floor system shall be evaluated by others to either verify the ribs are load carrying in fire or ignore the ribs as contributing to structural adequacy.

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 30th June 2026. 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. Summary of test reports for cast-in SNAP collars

Various Snap cast-in collars with various pipes were tested, their reports are summaries in Table A1.

Table A1: Summary of test reports for cast-in SNAP collars

Report	ID #	Collar	Element	Pipe Type	Pipe OD (mm)	Pipe thick. (mm)	Gap treatment		Pipe Config.	Integrity/ Insulation	Fitting	Gap (pipe/ collar) (mm)
							Collar and pipe	Collar and slab				
FP4640	6	(H50S)	150mm Concrete Slab	HDPE	56	3.3	None	Cast in	Stack	-/245NF/245NF		1.75
FP4640	5	(H100FWS)	150mm Concrete Slab + 35mm screed	PVC	56	2.4	Flush with screed	Grout backfill	Trap and Chromed brass grate	-/245NF/245F		
FP4837	5	H100S	150mm Concrete Slab	PVC SC	110	3.1	Bead of Bostik Firecaulk	Grout backfill	Stack	-/245NF/245NF		1
FP4837	6	L100FWS	150mm Concrete Slab + 35mm screed	PVC SC	110	3.1	Flush with screed	Grout backfill	Trap and ABS grate	-/241NF/241NF		
FP4837	7	(H100FWS)	150mm Concrete Slab	PVC SC	110	3.1	Bead of Bostik Firecaulk	Grout backfill	Stack	-/245NF/245NF		1
FR5670	2	H100FWS-RR	150mm Concrete Slab + 35mm screed	PVC SC with 500mm of acoustic lagging	110	3.1	Flash with screed	Grout backfill	Trap and floor grate	-/245NF/245F		
FR5670	22	H100FWS-RR	150mm Concrete Slab + 70mm screed	BEP PVC U SC	110	3.3	Flash with screed	Grout backfill	Trap and floor grate	-/245NF/245F		
FR5670	23	H100S-RR	150mm Concrete Slab	PVC	68.8	2.9	None	Cast in	Stack	-/245NF/73(rubber collar)		16.7
FR5670	24	(H50S-RR)	150mm Concrete Slab	PVC	43	2.5	None	Cast in	Stack	-/245NF/164(rubber collar)		10
FR5670	26	H50FWS-RR	150mm Concrete Slab + 35mm screed	HDPE	40.3	3.5	Flash with screed	Grout backfill	Trap and floor grate	-/245NF/245F		
FR5670	28	H65S-RR	150mm Concrete Slab	HDPE	40	3.3	Grout backfill	Cast in	Stack	-/245NF/245NF		19.5

Report	ID #	Collar	Element	Pipe Type	Pipe OD (mm)	Pipe thick. (mm)	Gap treatment		Pipe Config.	Integrity/ Insulation	Fitting	Gap (pipe/ collar) (mm)
							Collar and pipe	Collar and slab				
FSP1564	4	(H50FWS)	150mm Concrete Slab + 35mm screed	PVC	56	?(?)	Flash with screed	Grout backfill	Trap and chrome Brass grate	-/241NF/241NF	Y	
FSP1575	1	H100S-RR	150mm Concrete Slab	PVC	110	3	10mm deep Fuller Firesound	Cast in	Stack	-/241NF/241NF		1
FSP1575	2	H100S-RR	150mm Concrete Slab	PVC	83	3	Grout back fill 43mm deep	Cast in	Stack	-/241NF/241NF		18
FSP1575	3	L65S	150mm Concrete Slab	PVC	69	3	None	Cast in	Stack	-/241NF/241NF		
FSP1575	4	(H50S-RR)	150mm Concrete Slab	PVC	56	2	10mm deep Fuller Firesound	Cast in	Stack	-/241NF/241NF		1.75
FSP1575	5	L40S	150mm Concrete Slab	PVC	42	2	None	Cast in	Stack	-/241NF/241NF		
FSP1576	2	(H50FWS)	150mm Concrete Slab + 35mm screed	PVC	56	2.2	Flash with screed	Grout backfill	Trap and floor grate	-/241NF/241NF		
FSP1576	3	(H100FWS)	150mm Concrete Slab + 35mm screed	PVC	82.6	2.9	Flash with screed	Grout backfill	Trap and Chromed brass grate	-/241NF/241NF		
FSP1576	4	(H100FWS)	150mm Concrete Slab + 35mm screed	PVC SC	110	3.5	Flash with screed	Grout backfill	Trap and Chromed brass grate	-/241NF/241NF		
FSP1576	5	(H50FWS)	150mm Concrete Slab + 35mm screed	PVC	42.9	2.7	Flash with screed	Grout backfill	Trap and floor grate	-/241NF/241NF		
FSP1577	2	(H100S)	150mm Concrete Slab	PVC SC	110	3.5(3.5)	10mm deep Fuller Firesound	Cast In	Stack	-/241NF/241NF	Y	1
FSP1577	3	H100FWS-RR	150mm Concrete Slab + 35mm screed	PVC	65	2.7	Flush with screed	Cast In	Trap and Chromed brass grate	-/241NF/241NF		
FSP1577	4	H100FWS-RR	150mm Concrete Slab + 35mm screed	PVC SC	110	3.5(3.5)	Flush with screed	Cast In	Chromed brass grate	-/241NF/241NF	Y	

Report	ID #	Collar	Element	Pipe Type	Pipe OD (mm)	Pipe thick. (mm)	Gap treatment		Pipe Config.	Integrity/ Insulation	Fitting	Gap (pipe/ collar) (mm)
							Collar and pipe	Collar and slab				
FSP1577	5	H50S-RR	150mm Concrete Slab	PVC	42	2(2)	Grout backfill	Cast In	Stack	-/241NF/241NF	Y	18.75
FSP1577	1	(H100S)	150mm Concrete Slab	HDPE	110	5	10mm deep Fuller Firesound	Cast in	Stack	-/241NF/241NF		1
FSP1592	5	H50FWS-RR (H50FWS)	150mm Concrete Slab + 35mm screed	HDPE	56	2.5	Flush with screed	Cast In	Trap and floor grate	-/241NF/241NF		
FSP1592	4	L100FWS	150mm Concrete Slab + 35mm screed	HDPE	110	4.7	Flush with screed	Cast In	Trap and Chromed brass grate	-/241NF/241NF		
FSP1615	5	(H50S-RR)	150mm Concrete Slab	HDPE	50	4	10mm deep Sika Firerate sealant	Cast in	Stack	-/241NF/241NF		4.75
FSP1686	2	(H50FWS)	150mm Condeck Slab +35mm screed	HDPE	56	4	Flash with screed	Grout backfill	Trap and floor grate	-/241NF/241NF		
FSP1686	4	(H50FWS)	150mm Condeck Slab +35mm screed	PVC	56	2.5	Flash with screed	Grout backfill	Trap and floor grate	-/241NF/241NF		
FSP1696	5	H65S-RR	150mm Concrete Slab	HDPE	63	3.7	Bead of Fuller firesound	Cast in	Stack	-/241NF/241NF		8
FSP1696	1	H65S-RR	150mm Concrete Slab	PVC	69	3(?)	Bead of Fuller firesound	Cast in	Stack	-/241NF/241NF	Y	5
FSP1696	2	H65FWS-RR	150mm Concrete Slab + 35mm screed	PVC	69	3.2(3.2)	Flush with screed	Cast In	Trap and floor grate	-/241NF/241NF	Y	
FSP1696	3	H65S-RR	150mm Concrete Slab	PVC	56	2.6(?)	Bead of Fuller firesound	Cast in	Stack	-/241NF/241NF	Y	11.5
FSP1696	4	H65FWS-RR	150mm Concrete Slab + 35mm screed	PVC	56	2.6(2.6)	Flush with screed	Cast In	Trap and floor grate	-/241NF/241NF	Y	
FSP1700	2	H65S-RR	150mm Concrete Slab	HDPE	56	3.5	Bead of Fuller firesound	Cast in	Stack	-/241NF/241NF		11.5
FSP1700	3	H65FWS-RR	150mm Concrete Slab + 35mm screed	HDPE	56	3.5	Flush with screed	Cast In	Trap and Chromed brass grate	-/241NF/241NF		

Report	ID #	Collar	Element	Pipe Type	Pipe OD (mm)	Pipe thick. (mm)	Gap treatment		Pipe Config.	Integrity/ Insulation	Fitting	Gap (pipe/ collar) (mm)
							Collar and pipe	Collar and slab				
FSP1700	1	H65FWS-RR	150mm Concrete Slab + 35mm screed	HDPE	63	3.5	Flush with screed	Cast In	Trap and Chromed brass grate	-/241NF/241NF		
FSP1735	3	H65S-RR	150mm Concrete Slab	PVC	42.5	5(?)	Grout backfill	Cast in	Stack	-/241NF/241NF	Y	18.25
FSP1736	2	(H50S-RR)	150mm Concrete Slab	HDPE	40	3.3	Grout backfill to 20mm	Cast in	Stack	-/241NF/241NF		11.5
FSP1830	3	H100S-RR	150mm Concrete Slab	PVC	80	3(3)	20mm wide 10mm deep Silicon sealant	Grout backfill	Stack	-/241NF/241NF	Y	16
FSP1875	1	CC40	120mm Concrete Slab	PVC	43	2(2)	None	Grout backfill	Stack	-/241NF/222(grout)	Y	0
FSP1875	2	CC50	120mm Concrete Slab	HDPE	56	3.1	None	Grout backfill	Stack	-/241NF/238(grout)		0
FSP1875	3	CC50	120mm Concrete Slab	HDPE	50	3.5	None	Grout backfill	Stack	-/241NF/187(grout)		3
FSP1875	4	CC100	120mm Concrete Slab	HDPE	110	5	None	Grout backfill	Stack	-/241NF/209(grout)		0
FSP1875	5	CC40	120mm Concrete Slab	HDPE	40	3.5	None	Grout backfill	Stack	-/241NF/210(grout)		1.5
FSP1857	1	CC100	120mm Concrete Slab	PVC SC	110	3.6(3)	None	Grout backfill	Stack	-/241NF/207(grout)	Y	0
FSP1857	2	CC40	120mm Concrete Slab	PVC	43	2	None	Grout backfill	Stack	-/241NF/241NF		0
FSP1857	3	CC50	120mm Concrete Slab	PVC	56	2.3	None	Grout backfill	Stack	-/241NF/241NF		0
FSP1857	4	CC50	120mm Concrete Slab	PVC	56	2.3(2.3)	None	Grout backfill	Stack	-/241NF/241NF	Y	0
FSP1857	5	CC100	120mm Concrete Slab	PVC SC	110	3.3	None	Grout backfill	Stack	-/241NF/228 (grout)		0
FSP1882	1	H100S-RR	120mm concrete with steel permanent formwork Slab	PVC SC	110	3.7(3.7)	Bead of Fuller Firesound	Cast In	Stack	-/241NF/142 (mastic)	Y	3

Report	ID #	Collar	Element	Pipe Type	Pipe OD (mm)	Pipe thick. (mm)	Gap treatment		Pipe Config.	Integrity/ Insulation	Fitting	Gap (pipe/ collar) (mm)
							Collar and pipe	Collar and slab				
FSP1882	2	H100FWS-RR	120mm Steel permanent formwork Slab + 15mm screed	PVC SC	110	3.2(3.2)	Flash with screed	Cast In	Trap and Chromed brass grate	-/241NF/201 (grate)	Y	
FSP1882	3	H65S-RR	120mm Steel permanent formwork Slab	PVC	68.6	3(3)	Bead of Fuller Firesound	Cast In	Stack	-/241NF/148 (mastic)	Y	5.2
FSP1882	4	H50S-RR	120mm Steel permanent formwork Slab	PVC	43	2.3(2.3)	Bead of Fuller Firesound	Cast In	Stack	-/241NF/170(slab)	Y	10
FSP1882	5	H100FWS-RR	120mm Steel permanent formwork Slab + 15mm screed	HDPE PE 100 Gererit	110	5.15	Flash with screed	Grout backfill	Trap and Chromed brass grate	-/241NF/208(grate)		
FSP1882	6	H50S-RR	120mm Steel permanent formwork Slab	PVC	56	2.3(2.3)	Bead of Fuller Firesound	Cast In	Stack	-/241NF/174(slab)	Y	3.5
FSP1882	7	H50FWS-RR	120mm Steel permanent formwork Slab + 15mm screed	PVC	56	2.3(2.3)	Flash with screed	Cast In	Trap and Chromed brass grate	-/241NF/241NF	Y	
FSP1883	2	H100S-RR	120mm Steel permanent formwork Slab	HDPE PE100	110	5	10mm deep Fuller Firesound	Cast in	Stack	-/241NF/164(slab)		4.5
FSP1883	3	H50S-RR	120mm Steel permanent formwork Slab	HDPE	56	4	10mm deep Fuller Firesound	Cast in	Stack	-/241NF/183(slab)		3.5
FSP1883	4	H50FWS-RR	120mm Steel permanent formwork Slab +	HDPE	56	4	Flash with screed	Grout backfill	Trap and Chromed brass grate	-/241NF/159(grate)		

Report	ID #	Collar	Element	Pipe Type	Pipe OD (mm)	Pipe thick. (mm)	Gap treatment		Pipe Config.	Integrity/ Insulation	Fitting	Gap (pipe/ collar) (mm)
							Collar and pipe	Collar and slab				
			15mm screed									
FSP1883	6	H50S-RR	120mm Steel permanent formwork Slab	HDPE	50	4	10mm deep Fuller Firesound	Cast in	Stack	-/241NF/181(slab)		6.5
FSP1883	7	H50S-RR	120mm Steel permanent formwork Slab	HDPE	40	3.5	10mm deep Fuller Firesound	Cast in	Stack	-/241NF/200(slab)		11.5
FSP1986	2	H50FWS-RR	150mm Concrete Slab + 35mm screed	HDPE	40	3.8	Flush with screed	Cast In	Trap and Chrome brass grate	-/241NF/241NF		
FSP2002	4	H100S-RR	120mm Concrete Slab	PVC	55.8	2.21	Grout backfill	Grout backfill	Stack	-/241NF/234(slab)		31.6
FSP2008	2	H100FWS-RR	120mm Concrete Slab + 15mm screed	PVC SC	110	3.4	Flash with screed	Grout backfill	Trap and Chromed brass grate	-/241NF/235(slab 25mm from screed)		
FSP2008	3	H50S-RR	120mm Concrete Slab	PVC	43.35	2.21	Bead of Fuller Firesound	Grout backfill	Stack	-/241NF/205(slab)		9.825
FSP2016	1	H50S-RR	120mm Concrete Slab	PVC	55.85	2.23	Bead of Fuller Firesound	Grout backfill	Stack	-/241NF/177(slab)		3.575
FSP2016	2	H65S-RR	120mm Concrete Slab	PVC	68.68	2.85	Bead of Fuller Firesound	Grout backfill	Stack	-/241NF/184(slab)		5.16
FSP2016	3	H100S-RR	120mm Concrete Slab	PVC SC	110	3.4	Bead of Fuller Firesound	Grout backfill	Stack	-/241NF/148(slab)		4.5
FSP2028	3	H50S-RR	120mm Concrete Slab	HDPE	40.5	3.7	Bead of Fuller Firesound	Grout backfill	Stack	-/241NF/151(slab)		11.25
FSP2028	4	H100S-RR	120mm Concrete Slab	HDPE	110	5	Bead of Fuller Firesound	Grout backfill	Stack	-/241NF/155(slab)		4.5
FSP2028	5	H100FWS-RR	120mm Concrete Slab + 15mm screed	PVC SC + Sound lag lagging	110	3.7	Flush with screed	Cast In	Trap and Chromed brass grate	-/241NF/170(grate)		
FSP2116	1	H100S-RR	120mm Concrete Slab	PN12 PVC	114.5	total 6.37	None	Cast in	Stack	-/241NF/231(slab)		2.25
FSP2116	2	H100S-RR	120mm Concrete Slab	PN12 PVC	88.83	total 5.26	10mm deep Fuller Firesound	Cast in	Stack	-/241NF/186(slab)		15.085

Report	ID #	Collar	Element	Pipe Type	Pipe OD (mm)	Pipe thick. (mm)	Gap treatment		Pipe Config.	Integrity/ Insulation	Fitting	Gap (pipe/ collar) (mm)
							Collar and pipe	Collar and slab				
FSP2116	3	H50S-RR	120mm Concrete Slab	PN12 PVC	59.95	3.21	None	Cast in	Stack	-/241NF/241NF		1.525
FSP2116	4	H100S-RR	150mm Concrete Slab	Geberit HDPE	110	5.6	10mm deep Fuller Firesound	Cast in	Stack	-/241NF/241NF		4.5
FSP2177	3	H50S-RR	120mm Concrete Slab	PVC	43	2.2(2.2)	None	Cast In	Stack	-/241NF/241NF	Y	10
FSP2177	4	H100S-RR	120mm Concrete Slab	PVC	82	3	10mm deep Fuller Firesound and PE backing rod	Cast in	Stack	-/241NF/239(slab)		18.5
FSP2177	5	H100S-RR	120mm Concrete Slab	PVC SC	110	3.26(2.5)	None	Cast In	Stack	-/241NF/241NF	Y	4.5

A.2. Summary of test reports for SNAP retrofit collars

Snap 65-80R retrofit collar with various pipes were tested, their reports are summaries in Table A2.

Table A2: Summary of test reports for cast-in SNAP collars

Report	Pen. #	Collar	Intume-scent size	Element	Pipe Type	Pipe OD (mm)	Pipe thickness (mm)	Collar and pipe gap treatment	Collar install	Pipe Config.	Integrity/ Insulation
FSP 2090	3	65-80R	2 x 4 x 55	2x13mm+ 64mm stud (116mm)	PVC	81.5	2.88(total 5.76)	None	Retrofit	Fitting on fire side	-/241NF/150(collar)
FSP 1902	3	65-80R	2 x 4 x 55	2x13mm+ 64mm stud (116mm)	PVC	65	total 5.8	None	Retrofit	Fitting on fire side	-/181NF/181NF
FP4837	2	65-80R	2 x 4 x 56	150mm Concrete Slab	PVC	82.3	3.1	Bead of Bostik Firecaulk sealant	Retrofit	Stack	-/245NF/245NF
FP4837	9	65-80R	2 x 4 x 56	150mm Concrete Slab	PVC	69	3	Bead of Bostik Firecaulk sealant	Retrofit	Stack	-/245NF/245NF

A.3. The relevance AS 1530.4 -2005 of test data in accordance with to AS 1530.4 - 2014

The referenced fire resistance tests FP4640, FP4837, FR5670, FSP1564, FSP1575, FSP1576, FSP1577, FSP1592, FSP1615, FSP1686, FSP1696, FSP1700, FSP1735 and FSP1736 were conducted in accordance with AS 1530.4– 2005, which differs slightly from AS 1530.4–2014. These variations and their potential effect on the fire resistance performance of the referenced test specimen are discussed below.

Temperature Regime

The furnace heating regime in fire resistance tests conducted in accordance with AS 1530.4- 2014 follows a similar trend to that in AS 1530.4-2005. The specified specimen heating rate in AS 1530.4-2005 is given by:

$$T_t - T_0 = 345_{log}(8t+1) + 20$$

Where;

T_t = Furnace temperature at time t, in degrees Celsius.

T_o = Initial furnace temperature, in degrees Celsius, such that.

t = Time into the test, measured from the ignition of the furnace, in minutes.

The parameters outlining the accuracy of control of the furnace temperature in AS 1530.4– 2005 and AS 1530.4–2014 are not appreciably different.

Furnace Pressure

The furnace pressure conditions for single and multiple penetrations sealing systems in AS 1530.4-2005 and AS 1530.4-2014 are not appreciably different. The parameters outlining the accuracy of control of the furnace pressure in AS 1530.4-2014 and AS 1530.4-2005 are not appreciably different.

Performance Criteria

AS 1530.4-2014 specifies the following performance criteria for building materials and structures:

- Structural Adequacy – (Not relevant to the referenced test)
- Integrity
- Insulation

Integrity

The failure criteria for integrity in AS 1530.4-2014 and AS 1530.4-2005 are not appreciably different.

Insulation

The positions of thermocouples and failure criteria for insulation in AS 1530.4-2014 and AS 1530.4-2005 are not appreciably different.

Application of Test Data to AS 1530.4-2014

Based on the above discussion it is considered that the results of the referenced tests would not have been appreciably different if they were undertaken in accordance with AS 1530.4-2014.

Appendix B Analysis of Variations

B.1 Variation to pipe size and materials for cast-in collars

The proposed construction shall be Snap collars tested in Table 1 and listed in Tables 2-4, and subject to the following variations:

- The inclusion of SNAP collars as shown in Figures 1-7
- The inclusion of a low top version of the H100S-RR collar – L100S
- The inclusion of plastic pipes as shown in Tables 2 -4
- All collars to be grout backfilled between collar and support construction
- Plastic pipes to be supported above the slab and each side of the wall.
- Floor grate to be either chromed brass floor grate or ABS floor grate
- H100FSW-RR collars to require a minimum of 15mm screed coverage in 120mm slabs and 35mm screed coverage in 150mm -175mm slabs

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(SC) PVC and HDPE pipes 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 the 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 made reference to the requirements of this clause for the assessed pipes between 40mm and 110mm for pipes made from PVC, Sandwich Core PVC and HDPE.

Snap H100S-RR collar

Table B1: Test data of summary H100S-RR collar with PVC/PVC SC stack pipes

Report	Pen. #	Collar	Intume-scent size	Element	Pipe Type	Pipe OD (mm)	Pipe thickness (mm)	Integrity/ Insulation
FSP2002	4	H100S-RR	1 x 4 x 85	120mm Concrete Slab	PVC	55.8	2.21	-/241NF /234(slab)
FSP2177	4	H100S-RR	1 x 4 x 85	120mm Concrete Slab	PVC	82	3.28	-/241NF /239(slab)
FSP2016	3	H100S-RR	1 x 4 x 85	120mm Concrete Slab	PVC SC	110	3.4	-/241NF /148(slab)
FR5670	23	H100S-RR	1 x 3.8 x 90	150mm Concrete Slab	PVC	68.8	2.9	-/245NF /73 (rubber collar)
FSP1575	2	H100S-RR	1 x 4 x 85	150mm Concrete Slab	PVC	83	3	-/241NF /241NF
FSP1575	1	H100S-RR	1 x 4 x 85	150mm Concrete Slab	PVC	110	3	-/241NF /241NF
FP4837	5	H100S	1 x 4 x 85	150mm Concrete Slab	PVC SC	110	3.1	-/245NF/245NF
FSP1830	3	H100S-RR	1 x 4 x 85	150mm Concrete Slab	PVC	80	3(3)	-/241NF/241NF
FSP 1577	2	H100S	1 x 4 x 85	150mm Concrete Slab	PVC SC	110	3.5(3.5)	-/241NF /241NF
FSP2177	5	H100S-RR	1 x 4 x 85	120mm Concrete Slab	PVC SC	110	3.26(2.5)	-/241NF/241NF

Snap H100S-RR collar with PVC stack pipes

The proposed construction comprises a Snap H100S-RR collar protecting 50mm to 100mm PVC and PVC SC stack pipes penetrating through 120, 150 and 175mm thick slabs.

The H100S-RR collar is similar to the H100S collar except it was an additional rubber ring. As demonstrated in Table B1, the H100S-RR and the H100S collars are both able to allow 100mm PVC pipes to maintain integrity and insulation for up to 240 minutes.

Based on the above, the results of H100S-RR collars, and H100S can be analysed together as the same collar behaviour.

With reference to test data summarised in Table B1, various sizes and thicknesses of plastic pipes made from AUS PVC, Sandwich Core PVC, penetrated 120mm and 150mm thick concrete slabs and were protected with a Snap H100S-RR collar.

It is observed that these specimens all were able to maintain integrity for up to 240 minutes without failure. When the specimen failed insulation, it was due to the failure of the supporting construction or when the specimen wasn't grout backfilled in > 15mm gap between the pipe and the collar. The pipe was able to maintain insulation for up to 240 minutes

Therefore, the proposed variation to grout backfill all gaps that are greater than 15mm will allow the specimens to maintain insulation for up to 240 minutes when protected with an H100S-RR collar.

The PVC pipe sizes that were tested in the 120mm thick slabs were 50mm, 80mm and 100mm(SC). The PVC pipe sizes that were tested in the 150mm thick slabs were 65, 80, 100mm and 100mm(SC).

The proposed construction comprises decrease the slab thickness of FR 5670 specimen 23 from 150mm to 120mm and protected with an H100S-RR collar.

With reference to FR 5670 specimen 23, the 65mm PVC pipe when penetrating a 150mm slab and protected with an H100S-RR cast in collar, did not fail insulation on the pipe for up to 240 minutes with the pipe only measuring 55^{o}C temperature rise at 120 minutes and 70^{o}C at 240 minutes.

It is expected that with the decrease in slab thickness from 150mm to 120mm, the thermal mass of the system will be decreased by 20% resulting in a lesser heat sink effect and thus leading to a greater increase in pipe temperature over the period of the test.

However, with a large 125^{o}C margin in insulation performance of the pipe at 120 minutes, it is expected that the pipe will still be able to maintain insulation for up to 120 minutes when installed in a 120mm thick slab when protected with an H100S-RR collar.

The proposed construction comprises increase the slab thickness of FSP2002 specimen 4 from 120mm to 150mm and protected with an H100S-RR collar.

With reference to FSP2002 specimen 4, the 50mm PVC pipe when penetrating a 120mm slab and protected with an H100S-RR cast in collar, did not fail insulation on the pipe for up to 240 minutes and failed insulation at 234 minutes on the slab. The pipe did not fail insulation for up to 240 minutes.

It is expected that with the increase in slab thickness from 120mm to 150mm, the thermal mass of the system will be increased resulting in a greater heat sink effect and thus leading to a lesser increase in pipe temperature over the period of the test.

Therefore, it is expected that the PVC pipe will still be able to maintain insulation for up to 180 minutes when installed in a 150mm thick slab and protected with H100S-RR collars.

The proposed 175mm slab is even thicker and thus having more heat sink effect than the 150mm slab, and therefore the results of the pipes tested in the 120mm and the 150mm thick slab also applies to the 175mm slab. It is therefore expected that the pipes installed in a 170mm thick slab will be able to maintain insulation for up to 240 minutes when protected with H100S-RR collars.

Confidence in the ability of concrete slab to perform for the required FRL is offered by reference to AS 3600-2018 clause 5.5, where the required floor thicknesses by that standard are the same as those proposed for the given FRL.

Based on the above, it can be seen that the prequalification testing of the uPVC pipe sizes between 50 to 80mm and 100mm PVC SC have been met, and these pipes will be able to maintain integrity and insulation performance of up to 120 minutes in 120mm slabs, 180minutes in 150mm thick slabs and 240 minutes in 175mm thick slabs when protected with H100S-RR collars.

Based on the above, it can be expected the proposed construction will be able to maintain integrity and insulation for up to 120, 180 and 240 minutes based on the design if tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005.

Snap H100S-RR and H65-RR collar with HDPE stack pipes

Table B2: Test data of summary H100S-RR collar with HDPE stack pipes

Report	Pen. #	Collar	Intume-scent size	Element	Pipe Type	Pipe OD (mm)	Pipe thickness (mm)	Integrity/ Insulation
FR5670	28	H65S-RR	1 x 4.2 x 64	150mm Concrete Slab	HDPE	40	3.3	-/245NF/245NF
FSP1700	2	H65S-RR	1 x 5 x 65	150mm Concrete Slab	HDPE	56	3.5	-/241NF/241NF
FSP1696	5	H65S-RR	1 x 5 x 65	150mm Concrete Slab	HDPE	63	3.7	-/241NF/241NF
FSP1577	1	(H100S)	1 x 4 x 85	150mm Concrete Slab	HDPE	110	5	-/241NF/241NF
FSP2028	4	H100S-RR	1 x 4 x 85	120mm Concrete Slab	HDPE	110	5	-/241NF/155(slab)

The proposed construction comprises Snap H100S-RR and H65-RR collar protecting 63mm HDPE stack pipes penetrating through 150 and 175mm thick slabs.

With reference to FR 5670 specimen 28, a 40mm diameter HDPE pipe with a wall thickness of 3.3mm penetrated through a 150mm thick slab and was protected with an H65S-RR collar. It was able to maintain integrity and insulation for 245 minutes without failure.

With reference to FSP 1700 specimen 2, a 56mm diameter HDPE pipe with a wall thickness of 3.5mm penetrated through a 150mm thick slab and was protected with an H65S-RR collar. It was able to maintain integrity and insulation for 241 minutes without failure.

With reference to FSP 1696 specimen 5, a 63mm diameter HDPE pipe penetrated with a wall thickness of 3.7mm through a 150mm thick slab and was protected with an H65S-RR collar. It was able to maintain integrity and insulation for 241 minutes without failure.

The significance of the above tests demonstrated the ability of an H65S-RR collar to close off a range of HDPE pipe sizes from 40mm to 63mm with the 5mm thick 65mm tall intumescent strip inside the collar such that the pipe does not fail integrity nor insulation for 240 minutes.

The proposed 63mm HDPE pipe protected with an H100S-RR collar may result in earlier integrity or insulation failure of the pipe due to the gap between the pipe and the collar.

It is observed that the intumescent in the H100S-RR collar is larger than that in the H65S-RR collar and so is expected to provide more force to close off the pipe. Also, the spring in the H100S-RR collar will act to close off the gap between the collar and the pipe once it is set off within the first 7 minutes of the test. Therefore, it is expected that the H100S-RR collar will also act to close off the 63mm HDPE pipe.

Confidence in the H100S-RR collar to close off pipes that are much smaller than its inner diameter is shown in FSP2002 Specimen 4 where an H100S-RR collar was able to close off 50mm PVC when installed in a 120mm thick slab and allow the pipe to maintain integrity and insulation for 240 minutes.

Based on the above, and with 60 minutes margin on integrity and insulation, it is expected that the proposed H100S-RR collar will be able to close off the 63mm HDPE pipe when it is installed in a 150mm thick slab.

The proposed 175mm slab is even thicker and thus having more heat sink effect than the 150mm slab, and therefore the results of the pipes tested in the 150mm thick slab also apply to the 175mm slab. It is therefore expected that the pipes installed in a 170mm thick slab will be able to maintain insulation for up to 240 minutes when protected with H100S-RR collars.

Confidence in the ability of concrete slab to perform for the required FRL is offered by reference to AS 3600-2018 clause 5.5, where the required floor thicknesses by that standard are the same as those proposed for the given FRL.

Based on the above, it can be expected the proposed construction will be able to maintain integrity and insulation for up to 180 and 240 minutes based on the design if tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005.

Snap H100FWS-RR collar

Table B3: Test data summary of H100FWS-RR collar with PVC/PVC SC floor waste pipes

Report	Pen. #	Collar	Intume-scent size	Element	Pipe Type	Pipe OD (mm)	Pipe thickness (mm)	Pipe Config.	Integrity/ Insulation
FP4640	5	H100 FWS	1 x 4.4 x 85	150mm Concrete Slab + 35mm screed	PVC	56	2.4	Trap and Chromed brass grate	-/245NF /245NF
FSP1577	3	H100 FWS-RR	1 x 4 x 85	150mm Concrete Slab + 35mm screed	PVC	65	2.7	Trap and Chromed brass grate	-/241NF /241NF
FSP1576	3	H100 FWS	1 x 4 x 85	150mm Concrete Slab + 35mm screed	PVC	82.6	2.9	Trap and Chromed brass grate	-/241NF /241NF
FSP1576	4	H100 FWS	1 x 4 x 85	150mm Concrete Slab + 35mm screed	PVC SC	110	3.5	Trap and Chromed brass grate	-/241NF /241NF
FSP1577	4	H100 FWS-RR	1 x 4 x 85	150mm Concrete Slab + 35mm screed	PVC SC	110	3.5(3.5)	Chromed brass grate	-/241NF /241NF
FSP2008	2	H100 FWS-RR	1 x 4 x 85	120mm Concrete Slab + 15mm screed	PVC SC	110	3.4	Trap and chromed brass grate	-/241NF /235(slab 25mm from screed)
FP4837	6	L100 FWS	1 x 4 x 85	150mm Concrete Slab + 35mm screed	PVC SC	110	3.1	Trap and ABS grate	-/241NF /241NF

Snap H100FWS-RR collar with PVC floor waste pipes

The proposed construction comprises Snap H100FWS-RR collar protecting 50, 65 and 80mm PVC pipes and 100mm PVC SC floor waste pipes penetrating through 120, 150 and 175mm thick slabs.

The H100FWS-RR collars are similar to the H100FWS collar except it has an additional rubber ring. As demonstrated in Table B3, the H100FWS-RR and the H100FWS collars are both able to allow 100mm PVC pipes to maintain integrity and insulation for up to 240 minutes.

The L100 FWS collar is similar to the H100FWS collar except it does not have the moulded plastic high top section. The high top section does not contain any intumescent material and therefore does not contribute to the insulation performance of the specimen.

With reference to FP4837 specimen 6, the L100 FWS collar was also able to close off a 100mm PVC SC pipe when installed in a 150mm thick slab and able to maintain integrity and insulation for up to 240 minutes.

Based on the above, the results of H100FWS-RR collars, H100FWS and L100FWS can be analysed together as the same collar behaviour.

The proposed construction comprises Snap H100FWS-RR collar protecting 50mm to 80mm PVC pipes and 100mm PVC SC pipes penetrating through 120, 150 and 175mm thick slabs.

With reference to test data summarised in Table B3, various sizes and thicknesses of plastic pipes made from AUS PVC, Sandwich Core PVC, penetrated 120mm and 150mm thick concrete slabs and were protected with a Snap H100FWS-RR collar.

It is observed that these specimens all were able to maintain integrity for up to 240 minutes without failure. When the specimen failed insulation, it was due to the failure of the supporting construction.

The PVC pipe sizes that were tested in the 120mm thick slab were 100mm(SC). The PVC pipe sizes that were tested in the 150mm thick slabs were 50, 60, 80, 100mm(SC).

The proposed variation would require decreasing the slab thickness to 120mm for the PVC pipes that were tested in the 150mm thick slab in FP4640 specimen 5, FSP1577 specimen 3, FSP1576 specimen 3.

With reference to FP4640 specimen 5, the maximum temperature rise measured on the specimen by 120 minutes into the test was 61^{o}C on the grate.

With reference to FSP1577 specimen 3, the maximum temperature rise measured on the specimen by 120 minutes into the test was 63^{o}C on the grate.

With reference to FSP1576 specimen 3, the maximum temperature rise measured on the specimen by 120 minutes into the test was 98^{o}C on the grate.

It is expected that with the decrease in slab thickness from 150mm to 120mm, the thermal mass of the system will be decreased by 20% resulting in a lesser heat sink effect and thus leading to a greater increase in pipe temperature over the period of the test.

However, with an 82^{o}C to 119^{o}C margin in insulation performance at 120 minutes, it is expected that the 50, 65 and 80mm PVC pipe will still be able to maintain insulation for up to 120 minutes when installed in a 120mm thick slab and protected with H100FWS-RR collars.

Based on the above, it is expected that the proposed 50, 65 and 80mm PVC pipe will be able to maintain integrity and insulation for up to 120 minutes when installed in a 120mm thick slab and protected with H100FWS-RR collars.

The proposed 175mm slab is even thicker and thus having more heat sink effect than the 150mm slab, and therefore the results of the pipes tested in the 120mm and the 150mm thick slab also applies to the 175mm slab. It is therefore expected that the pipes installed in a 170mm thick slab will be able to maintain insulation for up to 240 minutes.

Confidence in the ability of concrete slab to perform for the required FRL is offered by reference to AS 3600-2018 clause 5.5, where the required floor thicknesses by that standard are the same as those proposed for the given FRL.

Based on the above, it can be seen that the prequalification testing of the uPVC pipe sizes between 50 to 80mm and 100mm PVC SC have been met, and these pipes will be able to maintain integrity and insulation performance of up to 120 minutes in 120mm slabs, 180minutes in 150mm thick slabs and 240 minutes in 175mm thick slabs when protected with H100FWS-RR collars.

Based on the above, it can be expected the proposed construction will be able to maintain integrity and insulation for up to 120, 180 and 240 minutes based on the design if tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005.

Snap H100FWS-RR collar with HDPE floor waste pipes

Table B4: Test data summary of H100FWS-RR collar with HDPE floor waste pipes

Report	Pen. #	Collar	Intume-scent size	Element	Pipe Type	Pipe OD (mm)	Pipe thickness (mm)	Pipe Config.	Integrity/ Insulation
FSP1592	4	L100F WS	1 x 4 x 85	150mm Concrete Slab + 35mm screed	HDPE	FSP1 592	4	Trap and Chromed brass grate	-/241NF/ 241NF
FSP1882	5	H100F WS-RR	1 x 4 x 85	120mm steel permanent formwork Slab + 15mm screed	HDPE PE 100	FSP1 882	5	Trap and Chromed brass grate	-/241NF/ 208(grate)

The proposed construction comprises Snap H100FWS-RR collar protecting 100mm HDPE floor waste pipes penetrating through 120, 150 and 175mm thick slabs

With reference to FSP1882 specimen 5, a 110mm diameter HDPE pipe with a wall thickness of 5.15mm penetrated through a 120mm thick concrete with steel permanent formwork slab with 35mm screed and was protected with as H100FWS-RR collar. It was able to maintain integrity for 241 minutes without failure and failed insulation at 208 minutes on the grate.

concrete with steel permanent formwork slab, due to its profile has slightly less thermal mass than a slab of the same thickness and thus result in pipe penetrations in it to performs slightly worse than if it were in a slab. Therefore, it is expected that when FSP1882 specimen 5 is tested in a 120mm thick slab, it will also be able to maintain integrity and insulation of 240minutes and 180 minutes respectively.

Based on the above, it is expected that the proposed construction will be able to maintain integrity and insulation for up to 240minutes and 180 minutes respectively when installed in a 120mm thick slab and protected with H100FWS-RR collars.

With reference to FSP 1592 specimen 4, a 110mm diameter HDPE pipe with a wall thickness of 4.7mm penetrated through a 150mm thick slab with a 35mm screed and was protected with an L100FWS collar. It was able to maintain integrity and insulation for 241 minutes without failure.

The L100 FWS collar is similar to the H100FWS collar except it does not have the moulded plastic high top section. The high top section does not contain any intumescent material and therefore does not contribute to the insulation performance of the specimen. Therefore the result of FSP 1592 specimen 4 can be applied to H100FWS collars.

The proposed 175mm slab is even thicker and thus having more heat sink effect than the 150mm slab, and therefore the results of the pipes tested in the 120mm and the 150mm thick slab also applies to

the 175mm slab. It is therefore expected that the pipes installed in a 170mm thick slab will be able to maintain insulation for up to 240 minutes.

Confidence in the ability of concrete slab to perform for the required FRL is offered by reference to AS 3600-2018 clause 5.5, where the required floor thicknesses by that standard are the same as those proposed for the given FRL.

Based on the above, it can be expected the proposed construction will be able to maintain integrity and insulation for up to 120, 180 and 240 minutes based on the design if tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005.

Combat Clean collars

Table B5: Test data summary of Combat Clean collar with stack pipes

Report	Pen. #	Collar	Intumescent size	Element	Pipe Type	Pipe OD (mm)	Pipe thickness (mm)	Pipe Config.	Integrity/ Insulation
FSP1875	1	CC40	1 x 8 x 38	120mm Concrete Slab	PVC	43	2(2)	Stack	-/241NF/ 222(grout)
FSP1875	2	CC50	1 x 8 x 38	120mm Concrete Slab	HDPE	56	3.1	Stack	-/241NF/ 238(grout)
FSP1875	3	CC50	1 x 8 x 38	120mm Concrete Slab	HDPE	50	2.5	Stack	-/241NF/ 187(grout)
FSP1875	4	CC100	1 x 12 x 48	120mm Concrete Slab	HDPE	110	5	Stack	-/241NF/ 209(grout)
FSP1875	5	CC40	1 x 8 x 38	120mm Concrete Slab	HDPE	40	3.5	Stack	-/241NF/ 210(grout)
FSP1857	1	CC100	1 x 12 x 48	150mm Concrete Slab	PVC SC	110	3.6(3)	Stack	-/241NF/ 207(grout)
FSP1857	2	CC40	1 x 8 x 38	120mm Concrete Slab	PVC	43	2	Stack	-/241NF/241NF
FSP1857	3	CC50	1 x 8 x 38	120mm Concrete Slab	PVC	56	2.3	Stack	-/241NF/241NF
FSP1857	4	CC50	1 x 8 x 38	120mm Concrete Slab	PVC	56	2.3(2.3)	Stack	-/241NF/241NF
FSP1857	5	CC100	1 x 12 x 48	120mm Concrete Slab	PVC SC	110	3.3	Stack	-/241NF/ 228(grout)

Combat Clean (CC) collars with PVC stack pipes

The proposed construction comprises Combat Clean collar protecting 40mm PVC, 50mm PVC and 100mm PVC SC stack pipes penetrating through 120, 150 and 175mm thick slabs, with and without fitting.

With reference to FSP 1857 specimen 2, a 43mm diameter PVC pipe with a wall thickness of 2mm penetrated through a 120mm thick slab and was protected with a CC40 collar. It was able to maintain integrity and insulation for 241 minutes without failure.

With reference to FSP 1875 specimen 1, a 43mm diameter PVC pipe with a wall thickness of 2mm with a 2mm thick fitting penetrated through a 120mm thick slab and was protected with a CC40 collar. It was able to maintain integrity for 241 minutes without failure and failed insulation at 222 minutes on the grout.

With reference to FSP 1857 specimen 5, a 110mm diameter PVC SC pipe with a wall thickness of 3.3mm penetrated through a 120mm thick slab and was protected with a CC100 collar. It was able to maintain integrity for 241 minutes without failure and failed insulation at 228 minutes on the grout.

With reference to FSP 1857 specimen 1, a 110mm diameter PVC SC pipe with a wall thickness of 3.6mm with a 3mm thick fitting penetrated through a 120mm thick slab and was protected with a CC100 collar. It was able to maintain integrity for 241 minutes without failure and failed insulation at 207 minutes on the grout.

With reference to FSP 1857 specimen 3, a 56mm diameter PVC pipe with a wall thickness of 2.3mm penetrated through a 120mm thick slab and was protected with a CC50 collar. It was able to maintain integrity and insulation for 241 minutes without failure. With reference to FSP 1857 specimen 4, a 56mm diameter PVC pipe with a wall thickness of 2.3mm with a 2.3mm thick fitting penetrated through a 120mm thick slab and was protected with a CC50 collar. It was able to maintain integrity and insulation for 241 minutes without failure.

The proposed 150mm and 175mm slab is thicker than the tested 120mm slab and thus would have more heat sink effect than the 120mm slab. Therefore, the results of the pipes tested in the 120mm slab would apply to the 150mm and 175mm slab. It is therefore expected that the pipes installed in a 150mm and 170mm thick slab will be able to maintain insulation for up to 180 minutes.

Confidence in the ability of concrete slab to perform for the required FRL is offered by reference to AS 3600-2018 clause 5.5, where the required floor thicknesses by that standard are the same as those proposed for the given FRL.

Based on the above, it can be expected the proposed construction will be able to maintain integrity and insulation for up to 120 and 180 minutes based on the design if tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005.

Combat Clean collars with HDPE stack pipes

The proposed construction comprises Combat Clean collar protecting 50mm and 100mm HDPE stack pipes penetrating through 120, 150 and 175mm thick slabs.

With reference to FSP 1875 specimen 2, a 56mm diameter HDPE pipe with a wall thickness of 3.1mm penetrated through a 120mm thick slab and was protected with a CC50 collar. It was able to maintain integrity and insulation for 241 minutes without failure and failed insulation at 238 minutes on the grout.

With reference to FSP 1875 specimen 3, a 50mm diameter HDPE pipe with a wall thickness of 3.5mm penetrated through a 120mm thick slab and was protected with a CC50 collar. It was able to maintain integrity for 241 minutes without failure and failed insulation at 187 minutes on the grout. With reference to FSP 1875 specimen 4, a 110mm diameter HDPE pipe with a wall thickness of 5mm penetrated through a 120mm thick slab and was protected with a CC100 collar. It was able to maintain integrity for 241 minutes without failure and failed insulation at 209 minutes on the grout. With reference to FSP 1875 specimen 5, a 40mm diameter HDPE pipe with a wall thickness of 3.5mm penetrated through a 120mm thick slab and was protected with a CC40 collar. It was able to maintain integrity for 241 minutes without failure and failed insulation at 210 minutes on the grout.

The proposed 150mm and 175mm slab is thicker than the tested 120mm slab and thus would have more heat sink effect than the 120mm slab. Therefore, the results of the pipes tested in the 120mm slab would apply to the 150mm and 175mm slab. It is therefore expected that the pipes installed in a 150mm and 170mm thick slab will be able to maintain insulation for up to 180 minutes.

Confidence in the ability of concrete slab to perform for the required FRL is offered by reference to AS 3600-2018 clause 5.5, where the required floor thicknesses by that standard are the same as those proposed for the given FRL.

Based on the above, it can be expected the proposed construction will be able to maintain integrity and insulation for up to 120 and 180 minutes based on the design if tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005.

B.2 Inclusion of fitting/coupling for cast-in collars

The proposed construction shall be Snap collars tested in Table 1 and listed in Tables 2-4, and subject to the following variations:

- The inclusion of pipe fitting/coupling for pipes as shown in Tables 2 - 4

H100S-RR collar

The proposed variation comprises PVC pipe with nominal diameter of 65mm, 80mm and 100mm(SC) and fitting be installed in 120, 150 and 175mm thick slab and protected with H100S-RR collars.

The proposed variation to include a sleeve/coupling inside the H100S-RR collar may affect and or delay collar closure.

With reference to FSP 2016 specimen 3, a 100mm PVC SC pipe was protected with an H100S-RR collar through a 120mm slab. The total PVC wall thickness was 3.4mm thick. The maximum temperature reached before the collar closed off the pipe was 26^{o}C measured on the pipe.

With reference to FSP 2177 specimen 5, a 100mm PVC SC pipe with a fitting was protected with an H100S-RR collar through a 120mm slab. The total PVC wall thickness was 5.76mm thick. The maximum temperature reached before the collar closed off the pipe was 84^{o}C measured on the pipe.

Both pipes were closed by the collar within 6 minutes of the start of the test and maintain integrity and insulation for up to 240 minutes.

With reference to FSP 1575 specimen 2, an 80mm PVC pipe was protected with an H100S-RR collar through a 150mm slab. The total PVC wall thickness was 3mm thick. The maximum temperature reached before the collar closed off the pipe was 32^{o}C measured on the pipe.

With reference to FSP 1830 specimen 3, an 80mm PVC pipe with a fitting was protected with an H100S-RR collar through a 150mm slab. The total PVC wall thickness was 6mm thick. The maximum temperature reached before the collar closed off the pipe was 47^{o}C measured on the pipe.

Both pipes were closed by the collar within 6 minutes of the start of the test and maintain integrity and insulation for up to 240 minutes.

The significance of the above comparison shows that the presence of the collar can result in a higher temperature spike on the pipe prior to pipe closure.

With reference to FR 5670 specimen 23, the 65mm PVC pipe was tested without fitting inside an H100S-RR collar and installed in a 150mm thick slab. The pipe itself was able to maintain insulation for up to 240 minutes with the maximum temperature rise measured on the pipe to be 70^{o}C at 240 minutes. The maximum temperature reached before the collar closed off the pipe was 23^{o}C measured on the pipe.

The proposed 65mm PVC pipe with fitting would result in a higher spike in pipe temperature prior to collar closure. However, the large insulation margin would allow the 65mm PVC pipe with fitting to be able to maintain insulation for at least 180 minutes in a 150mm slab when protected with an H100S-RR collar.

It is also expected that when installed in a 175mm thick slab, the 65mm, 80mm and 100mm pipe with fitting will be able to maintain insulation for up to 240 minutes since they did not fail insulation for 240 minutes when tested in thinner slabs.

Based on the above, it is considered that the proposed variation will not detrimentally affect the integrity and insulation performance of the proposed PVC pipes in the H100S-RR collar for up to 120,

180 and 240 minutes based on design when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1 -2005.

H100FWS-RR collar

The proposed variation comprises PVC pipe with a nominal diameter of 100mm(SC) and fitting be installed in 150 and 175mm thick slab and protected with H100FWS-RR collars.

The proposed variation to include a sleeve/coupling inside the H100FWS-RR collar may affect and or delay collar closure leading to earlier insulation failure of the floor grate.

With reference to FSP 1577 specimen 4, the 100 PVC SC pipe was tested in fitting when penetrating through a 150mm thick slab with 35mm screed and protected with an H100FWS-RR collar. The fitting did not affect the integrity and insulation of the specimen for up to 240 minutes.

It is also expected that when installed in a 175mm thick slab, the 100mm PVC SC pipe with fitting will be able to maintain insulation for up to 240 minutes since it did not fail insulation for 240 minutes when tested in thinner slabs.

Based on the above, it is considered that the proposed variations will not detrimentally affect the integrity and insulation performance of the proposed PVC SC pipe in H100S-RR collar for up to 180 and 240 minutes based on design when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1 -2005.

B.3 Variation to support construction for cast-in collars

The proposed construction shall be Snap collars tested in Table 1 and listed in Tables 2-4, and subject to the following variations:

- The inclusion of 120mm, 150mm and 175mm thick concrete with steel permanent formwork slab as a separating element
- concrete with steel permanent formwork slab modified to ensure 40mm grout backfill coverage around fire collar active area where required as per 13a
- The inclusion of active area of the collar less than 40mm from formwork rib as per Figure 13b

concrete with steel permanent formwork slab

Table B6: Test data summary of SNAP collars in concrete with steel permanent formwork slab

Report	Pen. #	Collar	Intumescent size	Element	Pipe Type	Pipe OD (mm)	Pipe thickness (mm)	Pipe Configuration	Integrity/ Insulation
FSP1883	7	H50S-RR	1 x 5 x 55	120mm concrete with steel permanent formwork Slab	HDPE	40	3.5	Stack	-/241NF/ 200(slab)
FSP2028	3	H50S-RR	1 x 5 x 55	120mm Concrete Slab	HDPE	40.5	3.7	Stack	-/241NF/ 151(slab)
FSP1883	3	H50S-RR	1 x 5 x 55	120mm concrete with steel permanent formwork Slab	HDPE	56	4	Stack	-/241NF/ 183(slab)
FSP1883	6	H50S-RR	1 x 5 x 55	120mm concrete with steel permanent formwork Slab	HDPE	50	4	Stack	-/241NF/ 181(slab)

Report	Pen. #	Collar	Intumescent size	Element	Pipe Type	Pipe OD (mm)	Pipe thickness (mm)	Pipe Configuration	Integrity/ Insulation
FSP1883	4	H50FWS-RR	1 x 5 x 55	120mm concrete with steel permanent formwork Slab + 15mm screed	HDPE	56	4	Trap and chromed brass grate	-/241NF/ 159(grate)
FSP1882	5	H100FWS-RR	1 x 4 x 85	120mm concrete with steel permanent formwork Slab + 15mm screed	HDPE PE 100 Geberit	110	5.15	Trap and chrome brass grate	-/241NF/ 208(grate)
FSP1882	1	H100S-RR	1 x 4 x 85	120mm concrete with steel permanent formwork Slab	PVC SC	110	3.7	Stack	-/241NF/ 142(mastic)
FSP1882	2	H100FWS-RR	1 x 4 x 85	120mm concrete with steel permanent formwork Slab + 15mm screed	PVC SC	110	3.2	Trap and Chromed brass grate	-/241NF/ 201(grate)
FSP1882	3	H65S-RR	1 x 5 x 65	120mm concrete with steel permanent formwork Slab	PVC	68.6	3	Stack	-/241NF/ 148(mastic)
FSP1882	4	H50S-RR	1 x 5 x 55	120mm concrete with steel permanent formwork Slab	PVC	43	2.3	Stack	-/241NF/ 170(slab)
FSP1882	6	H50S-RR	1 x 5 x 55	120mm concrete with steel permanent formwork Slab	PVC	56	2.3	Stack	-/241NF/ 174(slab)
FSP1882	7	H50FWS-RR	1 x 5 x 55	120mm concrete with steel permanent formwork Slab + 15mm screed	PVC	56	2.3	Trap and Chromed brass grate	-/241NF/ 241NF

The referenced specimens in Table B6 all of the collars were installed in the concrete with steel permanent formwork slab with at least 40mm between the collar body and the edge of the rib. Where the was insufficient space, the ribs were backfilled with grout to ensure a 40mm coverage around the collar.

The proposed construction comprises the inclusion of concrete with steel permanent formwork slab with an effective thickness of 120, 150 and 175mm as a support construction in place of concrete slabs.

With reference to Table B6, it is observed that when PVC and HDPE pipes are installed in 120mm thick concrete with steel permanent formwork slab and protected with various collars, the pipes were able to maintain integrity for up to 241 minutes without failure. With the stake pipes in concrete with steel permanent formwork slab, the points of insulation failure were either on the fire rated sealant or on the slab. For the floor waste pipes in concrete with steel permanent formwork, the point of insulation failure was almost always on the grate.

In contrast, when the pipes were installed in concrete as shown in Table B1 to B5, the point of failure was mostly on the slab or the grout backfill.

The different mode of failure is expected as concrete with steel permanent formwork slab has overall less concrete mass due to its profile and therefore has less heat sink effect to cool down the specimens on the unexposed side. However, it is observed that even with 120mm thick concrete with steel permanent formwork, the specimens tested were able to maintain integrity for up to 240 minutes and insulation of at least 120 minutes.

Based on the above it is shown that the 120mm thick concrete with steel permanent formwork slab would allow the proposed specimens to maintain integrity and insulation for up to 120 minutes, similar to when these specimens are installed in 120mm thick slabs.

With reference to Section A1, it can be seen that all the specimens that were tested in the 150mm thick slab where the collars were backfilled with grout, were able to maintain integrity and insulation for up to 240 minutes.

For the 150mm thick concrete with steel permanent formwork slab, despite the reduction in thermal mass compared to the 150mm thick slab, the 60 minutes margin in performance would allow the specimens installed in it to maintain integrity and insulation for up to 180 minutes.

For the 175mm thick concrete with steel permanent formwork slab, the increase in the overall concrete thickness from 150mm to 175mm would compensate for the reduction in concrete due to concrete with steel permanent formwork's profile.

Therefore, when the effective thickness of concrete with steel permanent formwork slab is increased to 150mm and 175mm, it is expected that the specimens in these thicker concrete with steel permanent formwork elements would perform similarly to the specimens tested in the 150mm and 175mm thick slabs.

Based on the above, it is expected that the proposed construction will be able to maintain integrity and insulation for up to 120, 180 and 240 minutes based on design when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1 -2005.

The proposed variation comprise the fire collars located with active area of the collar less than 40mm from formwork rib as per Figure 13b.

It is required that the structural adequacy of the floor system shall be evaluated by others to either verify the ribs are load carrying in fire or ignore the ribs as contributing to structural adequacy.

The insulation performance of the specimen may occur earlier due to less thermal heat sink in the area near the penetration. However, given the large insulation margin of the tested specimens, it is expected that the concrete slabs will be able to maintain insulation for up to 120, 180 and 240 minutes for 120, 150 and 175mm thick concrete with steel permanent formwork slabs.

Based on the above, it is expected that the proposed construction will be able to maintain integrity and insulation for up to 120, 180 and 240 minutes based on design when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1 -2005.

B.4 Variation to gap treatment for cast-in collars

The proposed construction shall be Snap collars tested in Table 1 and listed in Tables 2-4, and subject to the following variations:

- When the annular gap between the pipe and collar is less than 10mm, no sealant or backfilling is required.
- When the annular gap between the pipe and collar is 10mm but less than 15mm, a 10mm or deeper Fuller Firesound sealant with PE foam backing rod.
- When the annular gap between the pipe and collar is 15mm but less than 20mm, the gap shall be grout backfill to a depth of 30mm.

Table B7: Test data summary of PVC stack pipes protected with various collars and gap treatments

Report	Pen. #	Collar	Intume-scent size	Element	Pipe OD (mm)	Collar and pipe gap treatment	Collar and slab gap treatment	Integrity/ Insulation	Annular gap
FSP2177	3	H50S-RR	1 x 5 x 55	120mm Concrete Slab	43	2.2(2.2)	None	-/241NF/241NF	10
FSP2177	4	H100S-RR	1 x 4 x 85	120mm Concrete Slab	82	3	10mm deep Fuller Firesound and PE backing rod	-/241NF/239 (slab)	18.5
FSP1830	3	H100S-RR	1 x 4 x 85	150mm Concrete Slab	80	3(3)	10mm deep Silicon sealant	-/241NF/241NF	16
FR5670	23	H100S-RR	1 x 3.8 x 90	150mm Concrete Slab	68.8	2.9	None	-/245NF/73(rubber collar)	16.7
FSP1575	2	H100S-RR	1 x 4 x 85	150mm Concrete Slab	83	3	Grout back fill 43mm deep	-/241NF/241NF	18

With reference to Table B7, FSP2177 specimen 3 shows that when gaps are less or equal to 10mm, the specimen is able to maintain insulation on the pipe and the slab for up to 240 minutes.

FSP2177 specimen 4 shows that when gaps are less or equal to 18.5mm, the specimen when protected with 10mm depth of sealant, is able to maintain insulation on the pipe, sealant and for up to 240 minutes. The only failure was due to the slab which was only designed to maintain insulation for up to 120 minutes.

FSP1575 specimen 2 shows that when gaps are less or equal to 18mm, the specimen when protected with grout backfill between the pipe and the collar, is able to maintain insulation on the pipe, sealant and the slab for up to 240 minutes.

The proposed gaps are all less than that tested, and therefore it is expected that the insulation performance of the specimens will not be detrimentally affected for up to 240 minutes.

With reference to Section A1, it is shown that Fuller Firesound and other sealants were applied to seal off the unexposed side of the pipe penetration. None of them caused flaming or was associated with insulation failure for up to 240 minutes. Therefore these sealants can be used interchangeably in the proposed constructions.

Based on the above, it is expected that the proposed construction will not detrimentally affect the performance of the proposed collars' integrity and insulation for up to 120, 180 and 240 minutes based on design when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1 -2005.

B.5 Variation to cast-in collar body

The proposed construction shall be Snap collars tested in Table 1 and listed in Tables 2-4, and subject to the following variations:

- Collars can be trimmed as per Figures 8 and 9

By observation, the trimming of the collars as shown in Figures 8 and 9 are limited to the metal flange of the collar where no intumescent material is held.

The reduction in metal flange may in theory affect the activation of the intumescent material and the spring due to the reduction of the area of heat conduction from the outside of the collar into the collar. However, the open nature of the exposed end of the specimen would mean that furnace heat would travel directly to the inside of the collar through the gap between the pipe and the collar body or through the gap left by the burn off the plastic pipe in the early 5-10 minutes of the test such that this minor reduction in heat would not detrimentally affect the activation time of the intumescent material and the spring in the collar.

Based on the above, it is expected that the proposed construction will not detrimentally affect the performance of the proposed collars' integrity and insulation for up to 120, 180 and 240 minutes based on design when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1 -2005.

B.6 Retrofit collars - SNAP 65-80R

The proposed construction shall be Snap collars tested in Table 1 and listed in Table 5, and subject to the following variations:

- The inclusion of SNAP collars as shown in Figure 14
- The inclusion of pipe as shown in Table 5
- Plastic pipes to be supported above the slab and each side of the wall.
- The inclusion of minimum 116mm thick plasterboard lined walls, minimum 120mm thick concrete wall or block wall and minimum 150mm thick concrete slab as support construction.
- For slabs, when the annular gap between the pipe and collar is to be less than 5mm to be sealed with a bead of Fuller Firesound sealant
- Fixings for collar shall be as per Table 6b

Table B7: Test data summary of SNAP 65-80R collar with PVC pipes in walls and floors

Report	Pen. #	Collar	Intumescent size	Element	Pipe Type	Pipe OD (mm)	Pipe thickness (mm)	Collar and pipe gap treatment	Collar install	Pipe Config.	Integrity/ Insulation
FSP 2090	3	65-80R	2 x 4 x 55 x 300/ 325	2x13mm+ 64mm stud (116mm)	PVC	81.5	2.88(total 5.76)	None	Retrofit	Fitting on fire side	-/241NF/ 150
FSP 1902	3	65-80R	2 x 4 x 55 x 300/ 325	2x13mm+ 64mm stud (116mm)	PVC	65	total 5.8	None	Retrofit	Fitting on fire side	-/181NF/ 181NF
FP4837	2	65-80R	2 x 4 x 56 x 308/33 6	150mm Concrete Slab	PVC	82.3	3.1	Bead of Bostik Firecaulk sealant	Retrofit	Stack	-/245NF/ 245NF
FP4837	9	65-80R	2 x 4 x 56 x 308/33 6	150mm Concrete Slab	PVC	69	3	Bead of Bostik Firecaulk sealant	Retrofit	Stack	-/245NF/ 245NF

Plasterboard lined wall

The proposed construction comprises a 65-80R collar protecting 65mm and 80mm PVC pressure pipe (PN12) when penetrating a minimum 116mm thick plasterboard lined wall.

The PVC compounds with the greatest short-term and long-term strengths are those that contain no plasticisers and the minimum of compounding ingredients. This type of PVC is known as UPVC or PVC-U. Other resins or modifiers (such as ABS, CPE or acrylics) may be added to UPVC to produce compounds with improved impact resistance. These compounds are known as modified PVC (PVC-M). Flexible or plasticised PVC compounds, with a wide range of properties, can also be produced by the addition of plasticisers. Other types of PVC are called oriented PVC (PVC-O) which is PVC-U where the molecules are preferentially aligned in a particular direction. PVC-O is identical in composition to PVC-U and their general properties are correspondingly similar. The major difference lies in the mechanical properties in the direction of orientation. The composition of PVC-M differs by the addition of an impact modifier and the properties deviate from standard PVC-U depending on the type and amount of modifier used.

In this assessment a conservative approach has been applied to use the results of tests of UPVC with fitting included in the body of the collar to support the performance of UPVC, PVC-O or PVC-M pressure pipes of similar wall thickness (without fitting).

With reference to FSP 1902 specimen 3, a 65mm PVC pipe penetrated a 116mm thick plasterboard lined stud wall, and was protected on each side with a 65-80R collar. In the fireside collar, the PVC coupling was also installed such that the total PVC wall thickness in the collar came to 5.8mm. It was able to maintain integrity and insulation for 181 minutes without failure.

With reference to FSP 2090 specimen 3, an 80mm PVC pipe penetrated a 116mm thick plasterboard lined stud wall, and was protected on each side with a 65-80R collar. In the fireside collar, the PVC coupling was also installed such that the total PVC wall thickness in the collar came to 5.76mm. It was able to maintain integrity 241 minutes without failure and failed insulation on the collar at 150 minutes.

From the temperature profile of the pipe in FSP 1902 specimen 3 and FSP 2090 specimen 3, it is evident that the fireside collar was able to close off the pipe and the coupling within the first 7 minutes of the test.

The proposed 65mm and 80mm UPVC, PVC-O or PVC-M pressure pipe (PN12) has the same or less wall thickness as that of the PVC pipe and coupling tested in FSP 1902 and FSP 2090 respectively.

It is expected that the 65-80R collar would be able to close off 65mm and 80mm UPVC, PVC-O or PVC-M pressure pipe (PN12) such that the unexposed side pipe will not fail insulation for up to 120 minutes.

The non-fire side collars in FSP 1902 specimen 3 and FSP 2090 specimen 3, did not activate until after 120 minutes. Therefore, even though the specimens are asymmetrical in that coupling was only installed on the fireside, the fire performance of the tested specimens are applicable for a symmetrical specimen with a coupling on both side of the wall for up to 120 minutes.

Based on the above, it is expected that the proposed construction 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.

Concrete/block wall

The proposed construction comprises a 65-80R collar protecting 65mm and 80mm UPVC, PVC-O or PVC-M pressure pipe (PN12) when penetrating a minimum 120mm thick concrete wall or block wall.

The proposed 120mm thick concrete wall or block wall is thicker and has greater thermal mass than the tested 116mm plasterboard lined stud wall, and thus would have more heat sink effect than the

116mm plasterboard lined stud wall to absorb heat from the specimen. It is therefore expected that the specimen would be cooler on the non-fireside.

Therefore, the results of the above discussion for plasterboard wall can be applied to the 120mm concrete wall or block wall. It is therefore expected that the pipes installed in a 120mm concrete wall or block wall will be able to maintain integrity and insulation for up to 120 minutes.

Confidence in the ability of concrete wall or block wall to perform for the required FRL is offered by reference to AS 3600-2018 clause 5.7, where the required wall thicknesses by that standard are the same as those proposed for the given FRL.

Based on the above, it is expected that the proposed construction 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.

Concrete slab

The proposed construction comprises a 65-80R collar protecting 65mm and 80mm UPVC, PVC-O or PVC-M pressure pipe (PN12) when penetrating a minimum 150mm thick concrete slab.

With reference to FP4837specimen 2, an 80mm PVC pipe with a wall thickness of 3.1mm penetrated a 150mm thick concrete slab and was protected on the fireside with a 65-80R collar. It was able to maintain integrity and insulation for 245 minutes without failure. The maximum pipe temperature rise before pipe closure was 118^{o}C.

With reference to FP4837specimen 9, a 65mm PVC pipe with a wall thickness of 3mm penetrated a 150mm thick concrete slab, and was protected on the fireside with a 65-80R collar. It was able to maintain integrity and insulation for 245 minutes without failure. The maximum pipe temperature rise before pipe closure was 93^{o}C.

The proposed 65mm and 80mm PN 12 pipes both have a wall thickness that's thicker than the tested 65mm and 85mm pipes. This will affect the ability of the collar to close off the pipe, which may cause earlier integrity and insulation failure on the pipe.

With reference to FSP 1575 specimen 2, an 80mm PVC pipe with a wall thickness of 3mm penetrated a 150mm thick concrete slab and was protected on the fireside with an H100S-RR. The maximum pipe temperature rise before pipe closure was 32^{o}C and the maximum pipe temperature rise by 240 minutes was 71^{o}C.

With reference to FSP 1830 specimen 3, an 80mm PVC pipe with a wall thickness of 3mm penetrated a 150mm thick concrete slab and was protected on the fireside with an H100S-RR. A PVC coupling was also installed such that the total PVC wall thickness in the collar came to 6mm. The maximum pipe temperature rise before pipe closure was 41^{o}C and the maximum pipe temperature rise by 240 minutes was 55^{o}C.

With reference to FSP 1575 specimen 3, a 65mm PVC pipe with a wall thickness of 3mm penetrated a 150mm thick concrete slab, and was protected on the fireside with an L65S. The maximum pipe temperature rise before pipe closure was 19^{o}C and the maximum pipe temperature rise by 240 minutes was 49^{o}C.

With reference to FSP 1696 specimen 1, a 65mm PVC pipe with a wall thickness of 3mm penetrated a 150mm thick concrete slab, and was protected on the fireside with an H65S-RR. A PVC elbow was also installed such that the total PVC wall thickness in the collar came to 6mm. The maximum pipe temperature rise before pipe closure was 66^{o}C and the maximum pipe temperature rise by 240 minutes was 66^{o}C.

The significance of the above tests demonstrated that the presence of collar coupling which resulted in thicker pipe wall thickness in the collar does affect the closure of the pipe such that the temperature spike before pipe closure is higher.

Also, the 65-80R collar tested in FSP 4837 specimen 2 and 9 contains 5% more intumescent material than the proposed 65-80R collar. This may reduce the ability of the collar in closing the pipe and cause earlier integrity and insulation failure.

However, with 62^{o}C insulation margin for the 80mm PVC pipe tested in FP4837specimen 2 and 87^{o}C insulation margin for the 65mm PVC pipe tested in FP4837specimen 9 at 240 minutes, it is expected that the proposed 65-80R collar will be able to close off the proposed PN12 PVC pipe with the thicker pipe wall when installed in 150mm thick slab so as to be able to maintain integrity and insulation for up to 180 minutes.

The proposed 175mm slab is thicker than the tested 150mm slab and thus would have more heat sink effect than the 150mm slab. Therefore, the results of the pipes tested in the 150mm slab would apply to the 175mm slab. It is therefore expected that the pipes installed in the 170mm thick slab will be able to maintain insulation for up to 240 minutes.

Confidence in the ability of concrete slab to perform for the required FRL is offered by reference to AS 3600-2018 clause 5.5, where the required floor thicknesses by that standard are the same as those proposed for the given FRL.

Based on the above, it is expected that the proposed construction will maintain integrity and insulation for up to 180 and 240 minutes based on design when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1 -2005.

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