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Fire resistance of various Trafalgar cast-in fire collars when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005 Amdt.1

Assessment Report

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Report number: FCO-3475 Revision A

Date: 23/11/2022

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Report Details:

Report CSIRO Reference number: FCO-3475/CO5521

Report Status and Revision History:

VERSION	STATUS	DATE	DISTRIBUTION	ISSUE NUMBER
Initial Issue	Final	30/9/2022	CSIRO/ Client	FCO-3475
Revision A	Final	23/11/2022	CSIRO/ Client	FCO-3475

Report Authorization:

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	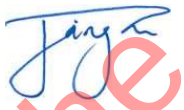	
23/11/2022	23/11/2022	23/11/2022

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1 Introduction

This report is an assessment of fire resistance of various Trafalgar cast-in fire collars when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005 Amdt.1.

This report is prepared for meeting the evidence of suitability requirements of NCC 2019 Volume 1 Schedule 5 clauses 2b) and 2 c) or NCC 2022 Volume 1 Clauses S1C2 (b) and (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 Sections 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
FSP 1050B	AS 1530.4 -1997	A fire resistance test of various penetrations in a 150 mm thick concrete slab protected with Trafalgar products.
FSP 1093B	AS 1530.4 -1997	A fire resistance test of various penetrations in a 150 mm thick concrete slab protected with Trafalgar products.
FSP 1358B	AS 1530.4 -2005	A fire resistance test of various penetrations in a 150 mm thick concrete slab protected with Trafalgar products.
FRT 210024	AS 1530.4 -2014	A fire resistance test of various penetrations in a 150 mm thick concrete slab protected with Trafalgar products.
FRT 210025	AS 1530.4 -2014	A fire resistance test of various penetrations in a 150 mm thick concrete slab protected with Trafalgar products.
FSP 2199	AS 1530.4 -2014	A fire resistance test of various penetrations in a 150 mm thick concrete slab protected with Trafalgar products.
FSP 2245	AS 1530.4 -2014	A fire resistance test of various penetrations in a 150 mm thick concrete slab protected with Trafalgar products.
FSP 2281	AS 1530.4 -2014	A fire resistance test of various penetrations in a 150 mm thick concrete slab protected with Trafalgar products.

The referenced tests FSP 1050B, FSP 1093B and FSP 1358B were tested at CSIRO North Ryde and are owned by Trafalgar Group Pty Ltd.

The referenced tests FSP 2199, FSP 2245 and FSP 2281 were tested at CSIRO North Ryde, and are sponsored by Trafalgar Group Pty Ltd.

The referenced tests FRT 210024 and FRT 210025 were tested at Warringtonfire VIC and are sponsored by Trafalgar Group Pty Ltd.

3 Proposed Variations

3.1 Cast-In collars protecting plastic stack pipes

The proposed construction shall be Cast-In collars tested in Table 1 and those listed in Tables 2-3, and subject to the following variations:

- Inclusion of FyreCOLLAR Cast-in High Collar (CHC) collars and FyreCOLLAR Cast-in Low Collar (CLC) as tested in FSP 2245 and FSP 2281
- For Cast-in collars as shown in Figures 1-2
  - The inclusion of plastic pipes as listed in Tables 2 -3
  - The inclusion of pipe fitting/coupling as same wall thickness as pipe, for pipes, as listed in Tables 2 -3
  - Pipework is to be vertically supported above the slab and optionally have an elbow configuration below the slab as per Figure 10a
- The proposed configurations are shown in Figures 1, 2, 3, 4, and 5.

Table 2: Concrete slab with collars protecting PVC/uPVC stack pipes

Pipe nominal diameter (mm)	Pipe wall thickness (mm)	Collar	Optional pipe fitting within the collar	Section 3.3 variation allowed	Config. of collar neck above the slab	Config. of pipe under the slab	Minimum slab thickness (X) (mm)
40	2	CHC40-65/ CLC-40	Yes	Yes	Figures 3, 4, 5	Straight or with elbow	150
50	2-3	CHC40-65/ CL-50					
65	3	CHC40-65/ CLC-65					
80	3	CHC80-100/ CLC-80					
90	3	CHC80-100					
100 or 100(SC)	3-4	CHC80-100/ CLC-100					

Table 3: Concrete slab with collars protecting HDPE (PE80, SDR 26) stack pipes

Pipe nominal diameter (mm)	Pipe wall thickness (mm)	Collar	Optional pipe fitting within the collar	Section 3.3 variation allowed	Config. of collar neck above the slab	Config. of pipe under the slab	Minimum slab thickness (X) (mm)
50	3.6	CHC40-65/ CLC-50	No	Yes	Figures 3, 4, 5	Straight or with elbow	150
56	3.4	CHC40-65/ CLC-50					
60	3	CHC40-65/ CLC-65					
75	3	CHC40-65/ CLC-65					
90	3-4.2	CHC80-100					
100	4.2	CHC80-100/ CLC-100					

Collar	Outer diameter	Inner Diameter	Height
CHC 40-65	162mm	107mm	250mm
CHC 80-100	215mm	160mm	250mm

Figure 1: CHC collar

Collar	Outer diameter	Internal diameter	Height
CLC40	162mm	107mm	80mm
CLC50	162mm	107mm	80mm
CLC65	162mm	107mm	80mm
CLC80	215mm	160mm	80mm
CLC100	215mm	160mm	80mm

Figure 2: CLC collar

3.2 Cast-In collars protecting metal pipes

The proposed construction shall be Cast-In collars tested in Table 1 and those listed in Tables 4-5, and subject to the following variations:

- FyreCOLLAR Cast-in High Collar (CHC) collars and FyreCOLLAR Cast-in Low Collar (CLC) shall be as tested in FSP 2245 and FSP 2281
- Inclusion of copper pipe listed in Table 4 and steel pipe listed in Table 5
- Inclusion of pipes protected with Twrap or Uniguard as shown in Figures 6 and 7 respectively
- The proposed configurations are shown in Figures 1, 2, 3, 4, 5, 6 and 7

Table 4: Concrete slab with collars protecting copper pipes

<table>
<tr><th>Type B copper pipes</th><th>Collar</th><th>Additional insulation materials above the slab</th><th>Section 3.3 variation allowed</th><th>Config. of collar neck above the slab</th><th>Minimum slab thickness (X) (mm)</th></tr>
<tr><td>DN32</td><td>CHC40-65/ CLC-40</td><td rowspan="2">300 Twrap tucked 15mm into concrete finished with 30mm fillet</td><td rowspan="9">Yes</td><td>Figures 3, 5, 6</td><td rowspan="9">150</td></tr>
<tr><td>DN40</td><td>CHC40-65/ CLC-40</td><td rowspan="2">Figures 3, 4, 5, 7</td></tr>
<tr><td>DN50</td><td>CHC40-65/ CLC-50</td><td rowspan="2">600 mm long Uniguard 30mm from pipe</td></tr>
<tr><td rowspan="2">DN50</td><td rowspan="2">CHC80-100/ CLC-50</td><td>Figures 3, 5, 6</td></tr>
<tr><td>300 Twrap tucked 15mm into concrete finished with 30mm fillet</td><td>600 mm long Uniguard 30mm from pipe</td><td>Figures 3, 4, 5, 7</td></tr>
<tr><td>DN65</td><td>CHC80-100/ CLC-65</td><td>600 mm long Uniguard 30mm from pipe</td><td>Figures 3, 4, 5, 7</td></tr>
<tr><td>DN80</td><td>CHC80-100/ CLC-80</td><td>600 mm long Uniguard 30mm from pipe</td><td>Figures 3, 4, 5, 7</td></tr>
<tr><td>DN100</td><td>CHC80-100/ CLC-100</td><td>600 mm long Uniguard 30mm from pipe</td><td>Figures 3, 4, 5, 7</td></tr>
</table>

Table 5: Concrete slab with collars protecting steel pipes

Medium grade Steel pipes	Collar	Additional insulation materials	Section 3.3 variation allowed	Config. of collar neck above the slab	Minimum slab thickness (X) (mm)
NB32	CHC40-65/ CLC-40	300 Twrap tucked 15mm into concrete finished with 30mm fillet	Yes	Figures 3, 5, 6	150
NB40	CHC40-65/ CLC-50	600 mm long Uniguard 30mm from pipe		Figures 3, 4, 5, 7	
NB50	CHC40-65/ CLC-65				
NB50	CHC80-100/ CLC-50	300 Twrap tucked 15mm into concrete finished with 30mm fillet		Figures 3, 5, 6	
		600 mm long Uniguard 30mm from pipe		Figures 3, 4, 5, 7	
NB65	CHC80-100/ CLC-65	600 mm long Uniguard 30mm from pipe		Figures 3, 4, 5, 7	
NB80	CHC80-100/ CLC-80	600 mm long Uniguard 30mm from pipe		Figures 3, 4, 5, 7	
NB100	CHC80-100/ CLC-100	600 mm long Uniguard 30mm from pipe		Figures 3, 4, 5, 7	

3.3 Various ways of installing Cast-In collars with plastic stack pipes and metal pipes

The proposed construction in Section 3.1 to Section 3.2 of this report may include the following variations in isolation or combination:

- The inclusion of all the services and collars listed in Tables 2-5
- The inclusion of concrete slab as a separating element
    - Inclusion of a minimum 150mm and 175mm thick concrete slab
    - All cast-in collars are to be cast in during construction or grout backfilled between the outside of the collar and support construction
- Inclusion of Trafalgar Fyreflex sealant for services protected with CHC cast-in collars as per Figures 3 and 4
- Gap treatment between CHC cast-in collar and pipe as per Table 6 as per Figures 3 and 4
- The inclusion of variation to collar body
    - The CHC Cast-in collars casing above the active area of the collar can be cut to be flush with the slab as shown in Figure 3 for all services listed in Tables 2, 3, 4, 5
    - The Cast-in collars flange can be damaged or partially removed outside the active area of the collar as shown in Figure 8
- The following variation to collar location and orientation variation
    - Spacing between adjacent penetrations to be 40mm (flange to flange) as per AS 4072.1 clearance clause 4.9.3 as shown in Figure 9
    - The clearance between the collar and the edge of the slab is to be a minimum of 100mm as shown in Figure 9
    - The cast-in collar can be installed horizontally on the side of a concrete beam when protecting stack pipes and metal pipes as shown in Figure 10
    - A minimum 200mm clearance is required under the collar that is free from obstructions by walls or other features

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

Pipe material	The gap between the collar and stack pipe on the unexposed side of the slab	Gap treatment
Plastic	<20mm	Fill with 10mm or deeper Fyreflex sealant and PE foam backing rod
Metal	<10mm	Fill with 10mm or deeper Fyreflex sealant and optional PE foam backing rod

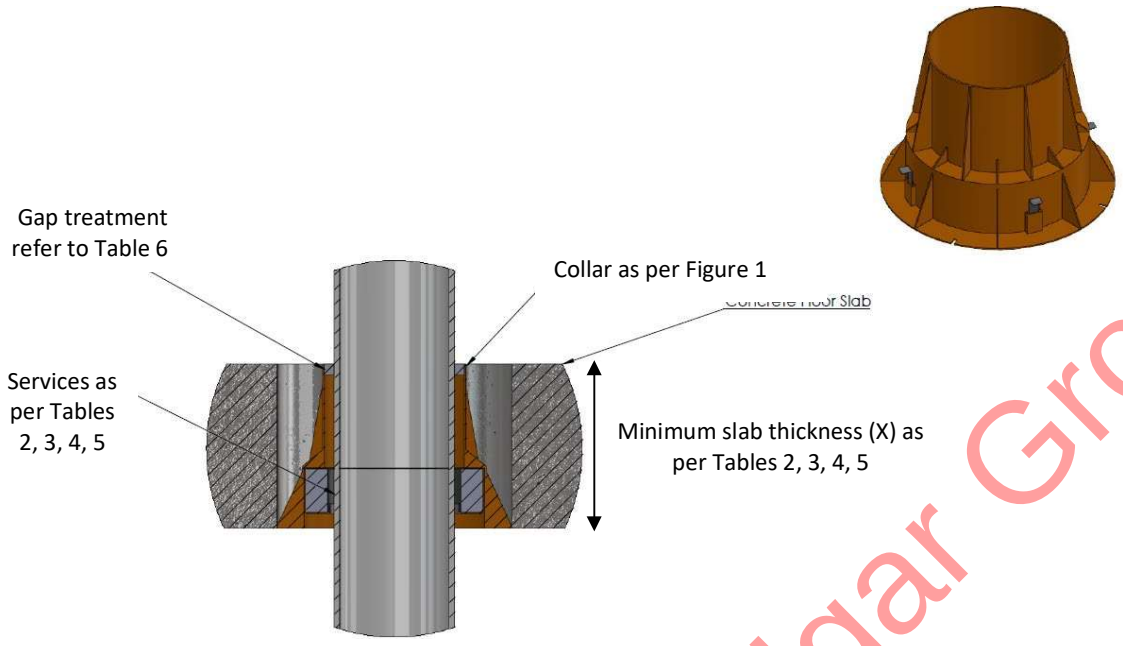

Figure 3: CHC collar with collar neck flush slab and gap filled with 10mm depth of sealant

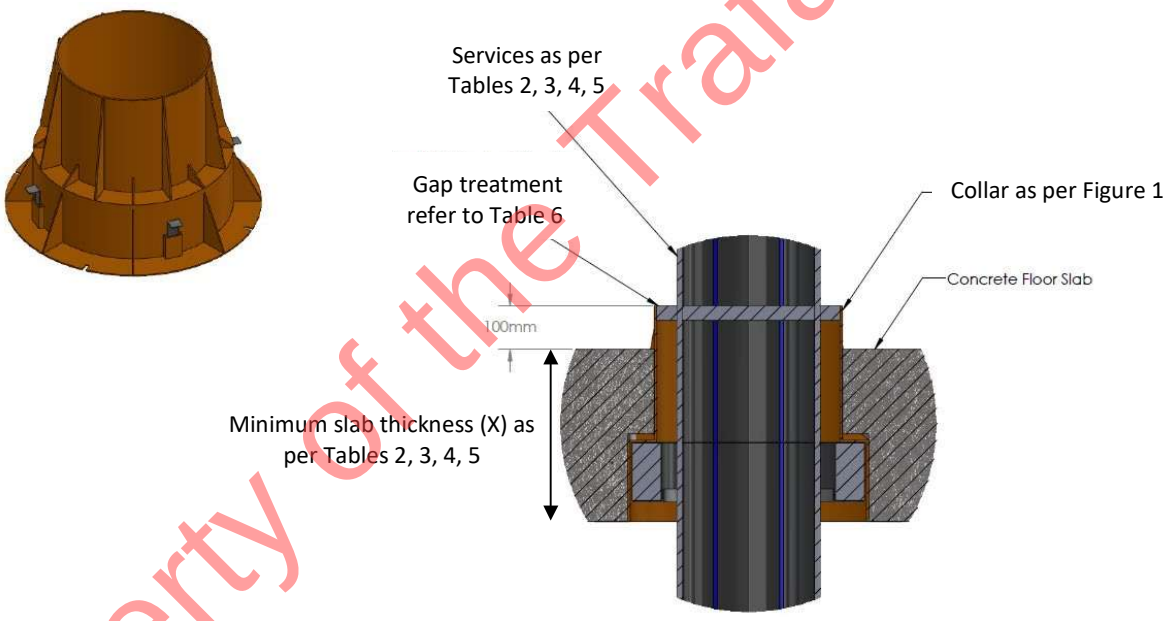

Figure 4: CHC collar with collar neck 100mm above slab and gap filled with 10mm depth of sealant

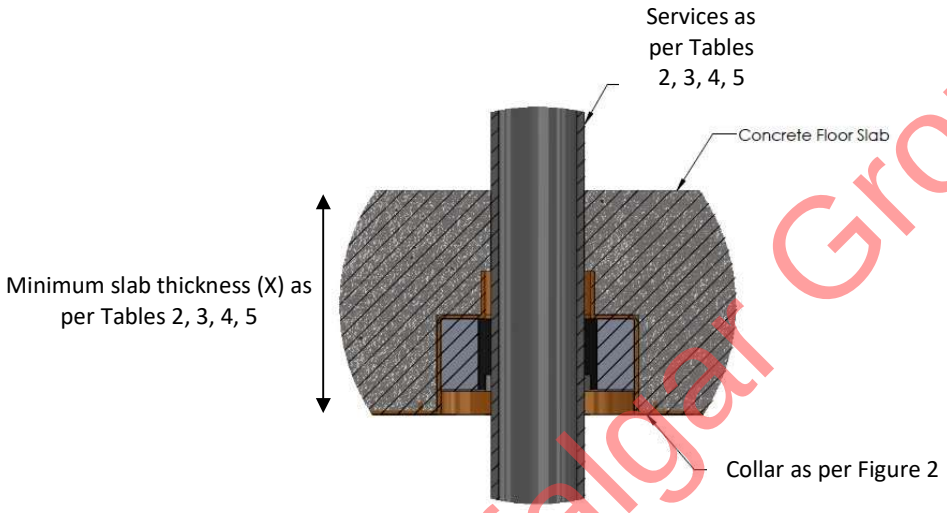

Figure 5: CLC collar where the gap between slab and service filled with 10mm depth of sealant

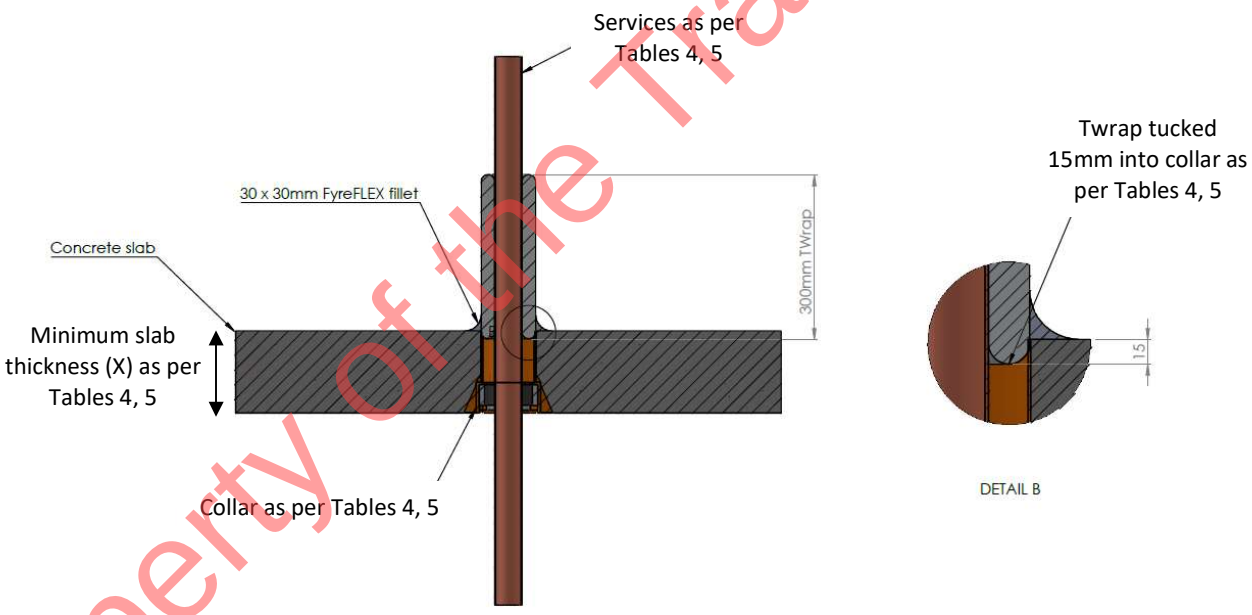

Figure 6: CHC or CLC collar with wrapped metal pipes

Services as per Tables 4, 5

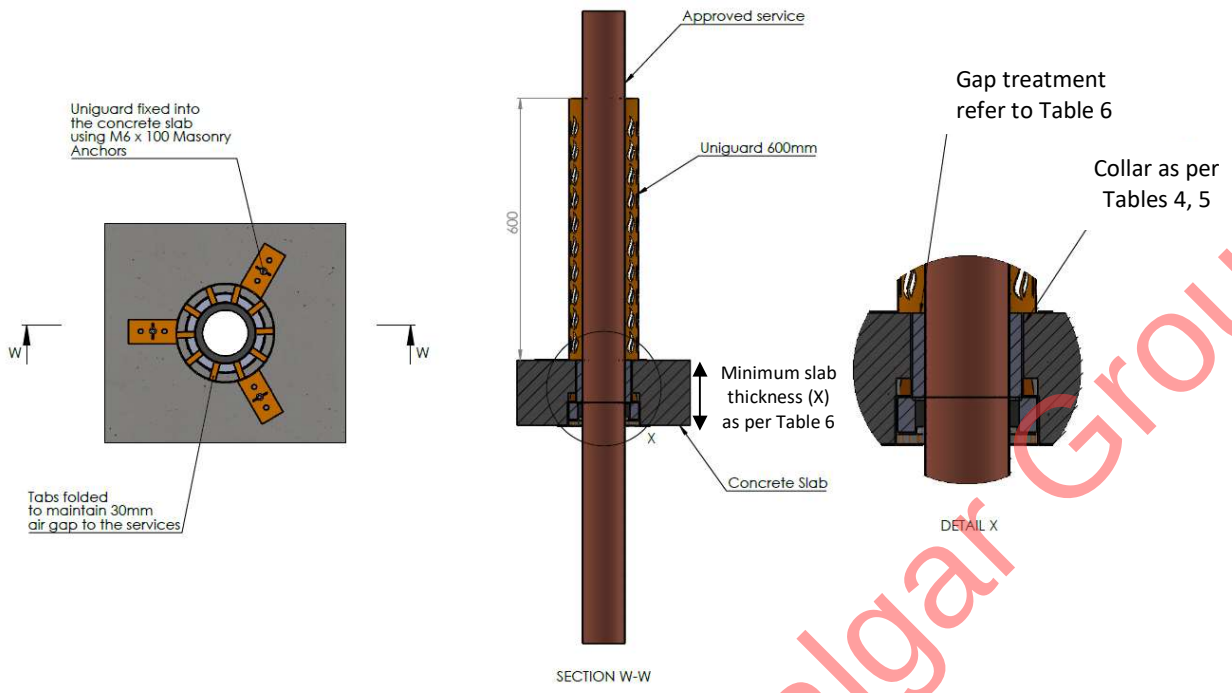

Figure 7: CHC or CLC collar with metal pipes protected by Uniguard

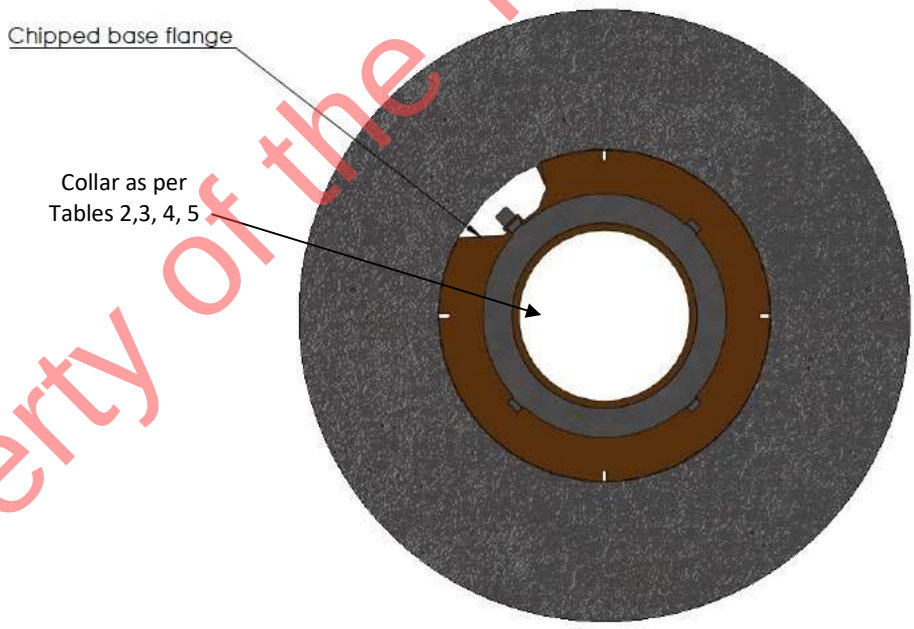

Figure 8: Collar flanges that are damaged or partially removed on the plastic base flange

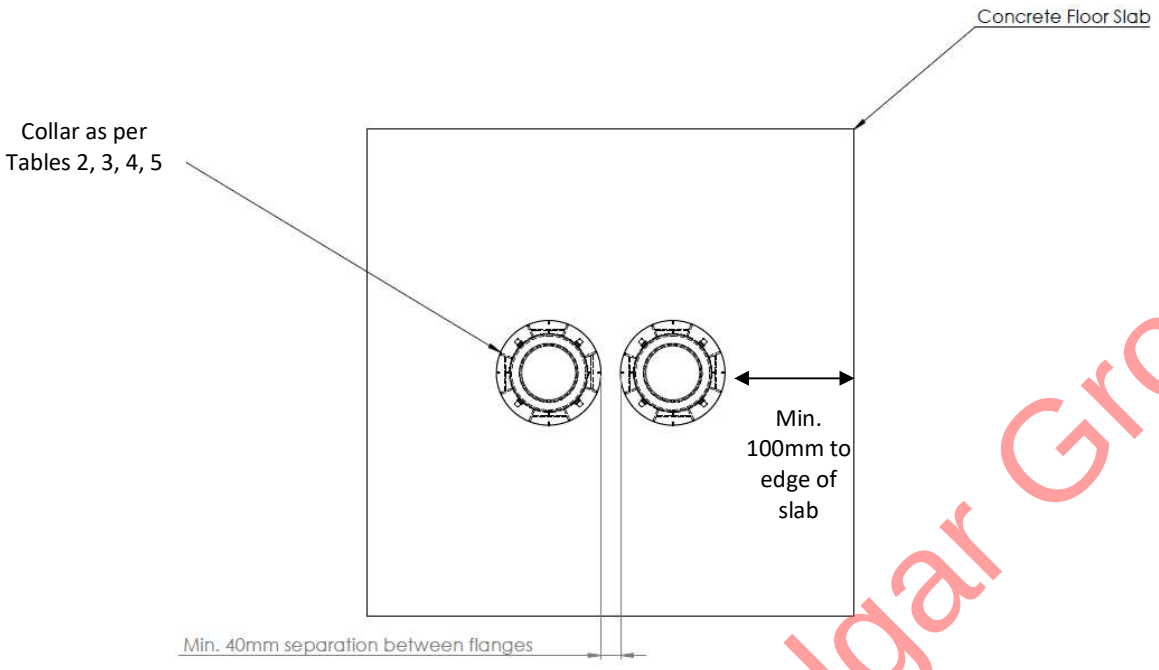

Figure 9: Spacing between adjacent penetrations confirmed to be 40mm (flange to flange)

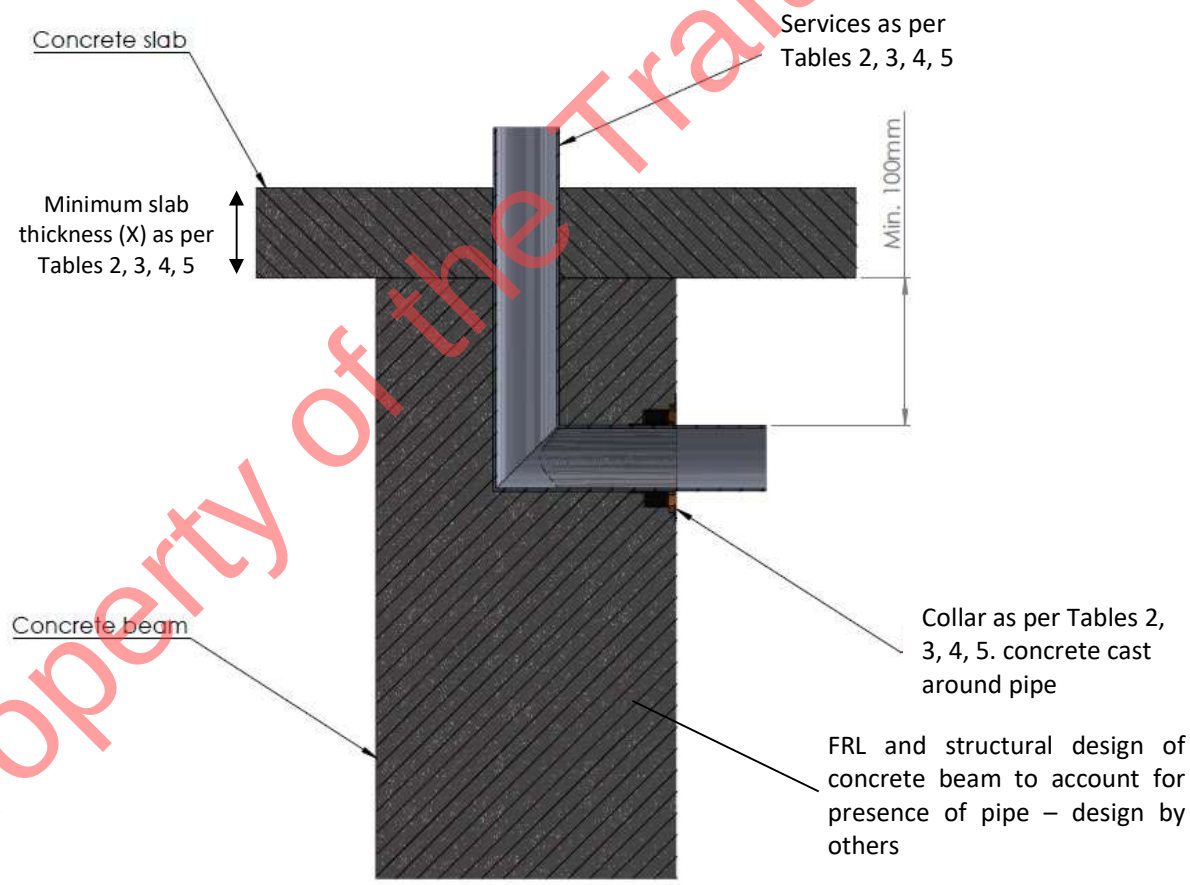

Figure 10: CHC or CLC collar installed on the side of a beam – for stack pipes and metal pipes only

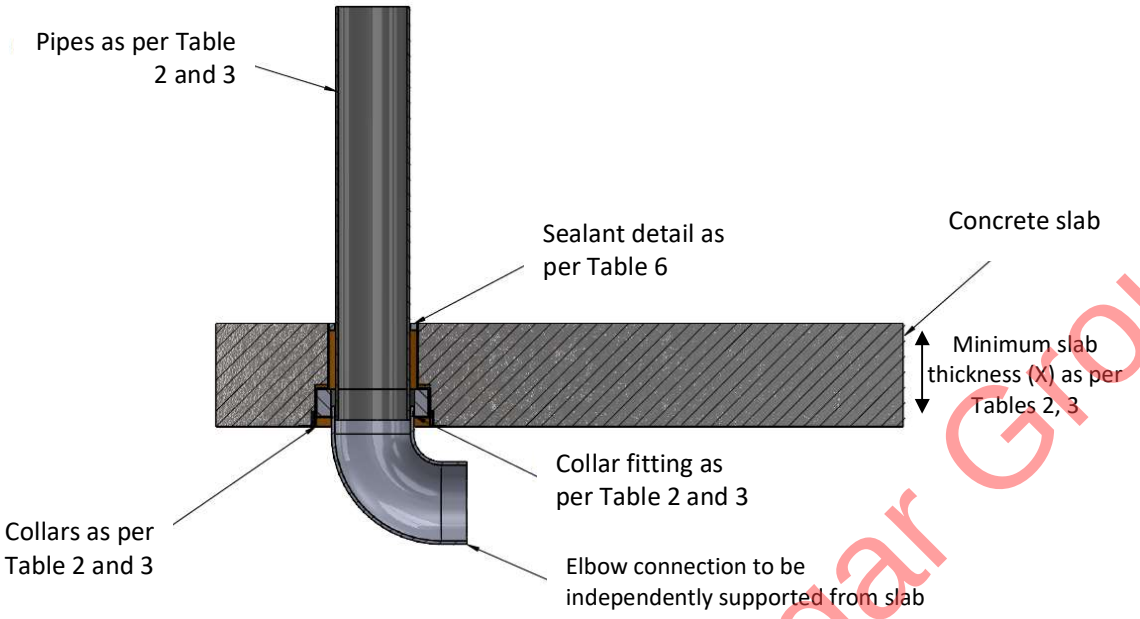

Figure 10a: PVC Stack pipe configuration with elbow

3.4 Cast-In collars protecting paircoil bundle installation

The proposed construction shall be Cast-In collars tested in Table 1 and those listed in Table 7, and subject to the following variations:

- FyreCOLLAR Cast-in High Collar (CHC) collars shall be as tested in FSP 2245 and FSP 2281
- Inclusion of a paircoil bundle installation with and without wraps that are listed in Table 7
- The proposed configurations are shown in Figures 1, 11 and 12

Table 7: Concrete slab with collars protecting paircoil bundle installation

Service	Number of services	Collar	Additional insulation materials above the slab	Section 3.4 variation allowed	Config. of collar neck above the slab	Minimum slab thickness (X) (mm)
1 paircoil bundle installation: 3/8 + 3/4 paircoil with 19mm thick Arden Superpair FR insulation 1 x 25mm diameter (1.5mm wall thickness) Aussie Duct aircon and refrigeration drainpipe	Up to 2 x paircoil bundles	CHC80-100	No Twrap	Yes	Figure 11	150
	Up to 2 x paircoil bundles		300 Twrap		Figure 12	
	1 x paircoil bundle	CHC40-65	300 Twrap		Figure 12	

3.5 Various ways of installing cast-In collars with the installation of paircoil bundle

The proposed construction in Section 3.4 of this report may include the following variations in isolation or combination:

- The inclusion of all the services and collars listed in Table 7
- The inclusion of concrete slab as a separating element
    - Inclusion of a minimum 150mm and 175mm thick concrete slab
    - All cast-in collars are to be cast-in during construction or grout backfilled between the outside of the collar and support construction
- Gap treatment between the cast-in collar and installation of paircoil bundle as listed in Table 8
    - Where the annular gap between the installation of paircoil bundle and collar is 20mm or less, fill the gap with a 10mm or deeper Fyreflex sealant controlled with a PE foam backing rod
- The inclusion of variation to collar body
    - The CHC Cast-in collars casing above the active area of the collar can be cut to be flush with the slab as shown in Figure 12 for services with wrap listed in Table 6
    - The Cast-in collars flange can be damaged or partially removed outside the active area of the collar as shown in Figure 8
- The following variation to collar location and orientation variation
    - Spacing between adjacent penetrations to be 40mm (flange to flange) as per AS 4072.1 clearance clause 4.9.3 as shown in Figure 9
    - The clearance between the collar and the edge of the slab is to be a minimum of 100mm as shown in Figure 9
    - A minimum 200mm clearance is required under the collar that is free from obstructions by walls or other features

Table 8: Gap treatment between the cast-in collar and installation of paircoil bundle

The gap between the collar and installation of paircoil services on the unexposed side of the slab	Gap treatment
<20mm	Fill with 10mm or deeper Fyreflex sealant and PE foam backing rod
<10mm	Fill with 10mm or deeper Fyreflex sealant and optional PE foam backing rod

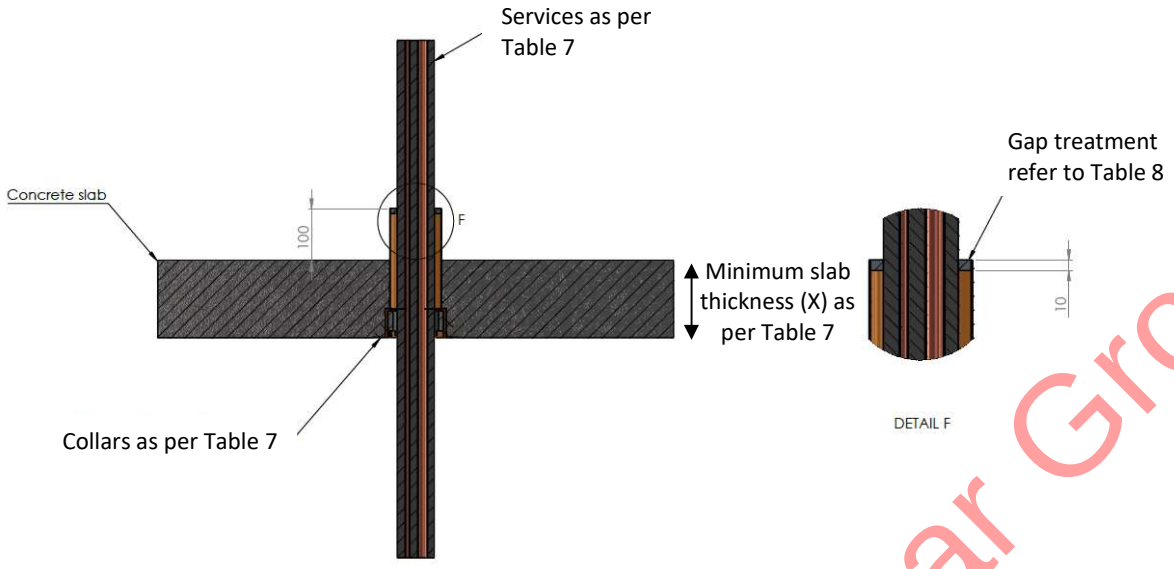

Figure 11: CHC collar protecting paircoil bundle

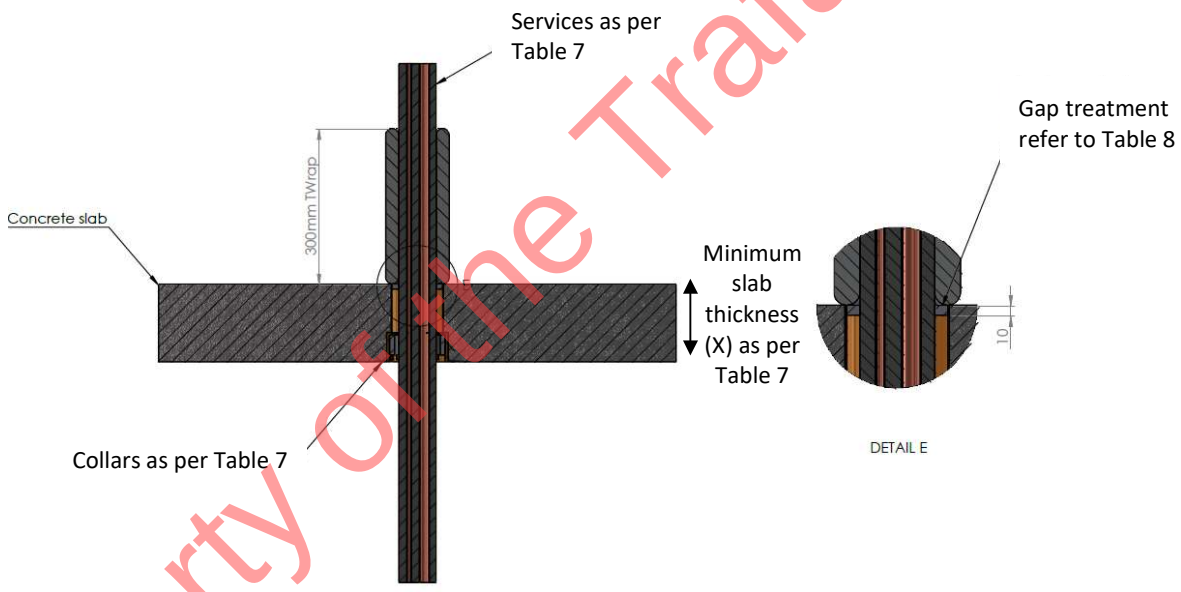

Figure 12: CHC collar protecting paircoil bundle with Twrap

3.6 Cast-In collars protecting plastic floor waste pipes

The proposed construction shall be Cast-In collars tested in Table 1 and those listed in Table 9, and subject to the following variations:

- For FW 100 High and Low Cast-in collars as shown in Figures 13 and 14 respectively
  - The inclusion of plastic pipes as listed in Table 9
  - The floor waste grate shall be a chromed brass floor grate
  - Pipe socket/fitting to be located outside the cast-in collar
- The proposed configurations are shown in Figures 13, 14, 15 and 16

Table 9: Concrete slab with collars protecting various plastic floor waste pipes

Pipe Material	Pipe nominal diameter (mm)	Pipe wall thickness (mm)	Collar	Optional pipe fitting within the collar	Section 3.4 variation allowed	Config. of pipe under the slab	Minimum slab thickness (X) (mm)
PVC (SC) (SN6)	100	3.5-4	Low-Cast FW Collar	No	Yes	Figure 13	150
	100		High-Cast FW Collar			Figure 13	
	100		Low-Cast FW Collar			Figure 14	
	100		High-Cast FW Collar			Figure 14	
HDPE (PE 100, SDR 26)	100	5	Low-Cast FW Collar			Figure 13	
	100		Low-Cast FW Collar			Figure 14	
Rehua Raupiano Plus PP	100	3.4	Low-Cast FW Collar			Figure 13	
DBlue	100	3.4	Low-Cast FW Collar			Figure 13	

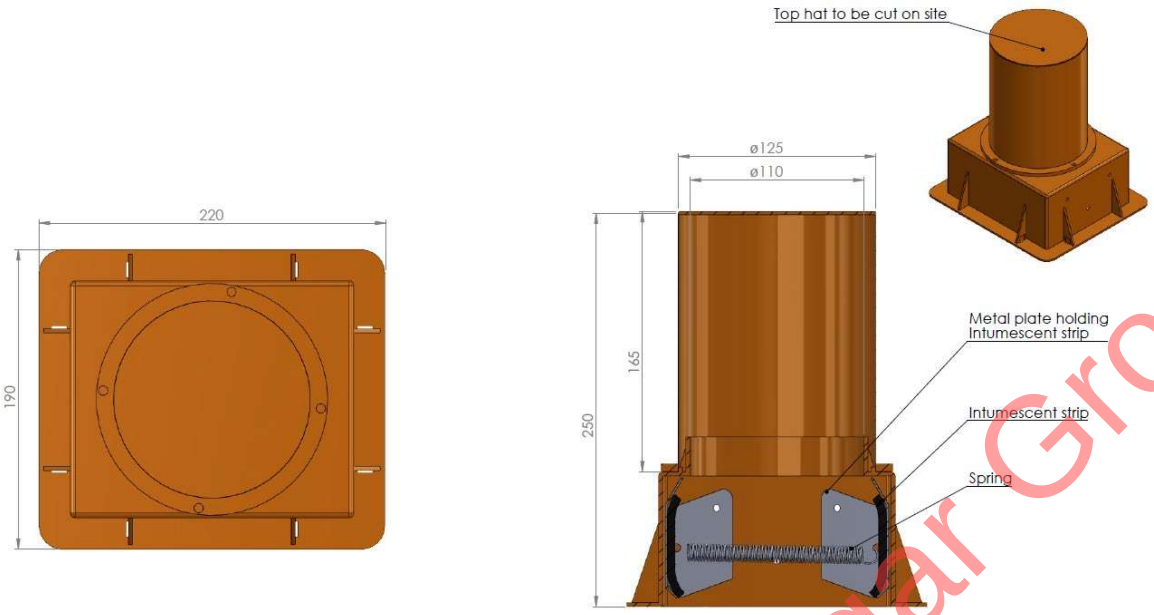

Figure 13: FW-100 High Cast-in collar

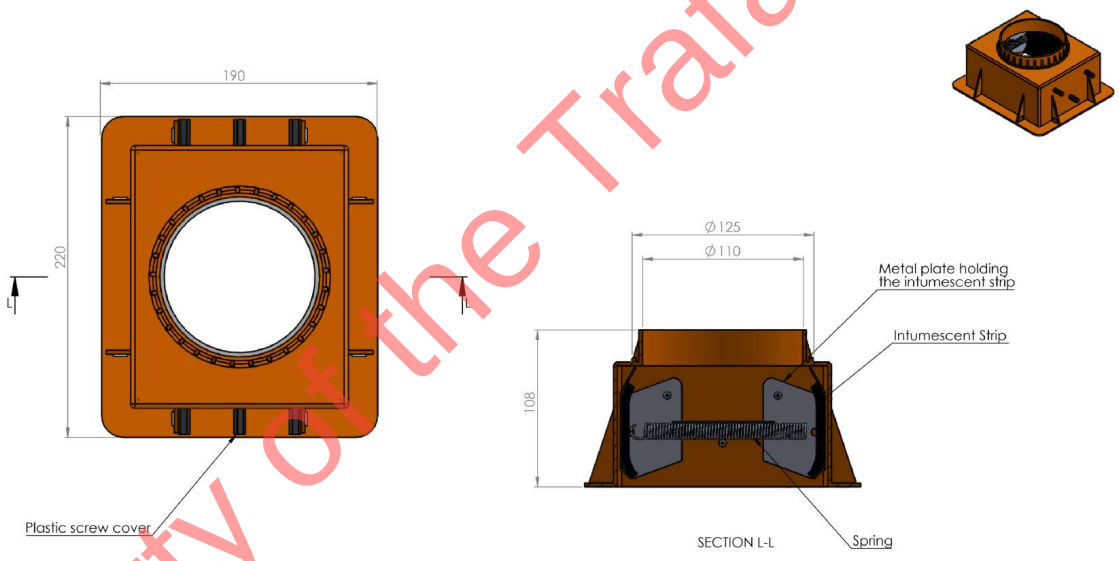

Figure 14: FW-100 Low Cast-in collar

3.7 Various ways of installing cast-In collars with floor waste pipes

The proposed construction in Section 3.6 of this report may include the following variations in isolation or combination:

- The inclusion of all the services and collars listed in Table 9
- The inclusion of concrete slab as a separating element
    - Inclusion of a minimum 150mm and 175mm thick concrete slab
    - All cast-in collars are to be cast-in during construction or grout backfilled between the outside of the collar and support construction
    - The exposed side of floorwaste pipes can be in a 4-way gully or P – trap configuration as listed in Table 9 and shown in Figures 15 and 16 respectively
- The following variation to collar location and orientation variation
    - Spacing between adjacent penetrations to be 40mm (flange to flange) as per AS 4072.1 clearance clause 4.9.3 as shown in Figure 17
    - The clearance between the collar and the edge of the slab is to be a minimum of 100mm as shown in Figure 17
    - A minimum 200mm clearance is required under the collar that is free from obstructions by walls or other features

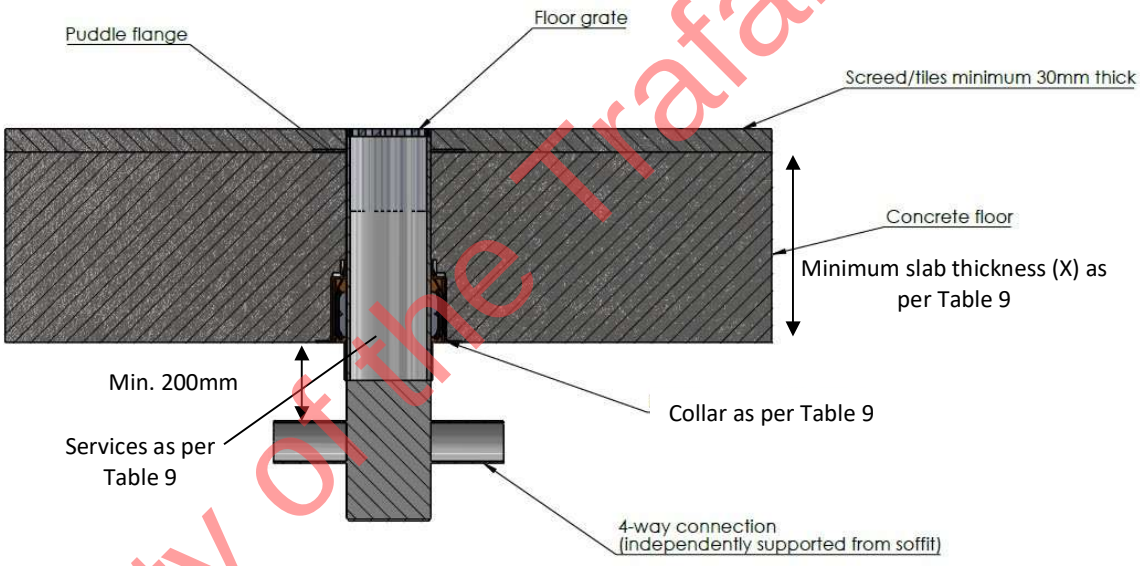

Figure 15: FW Cast-in collar with Floor waste pipes – 4-way gully

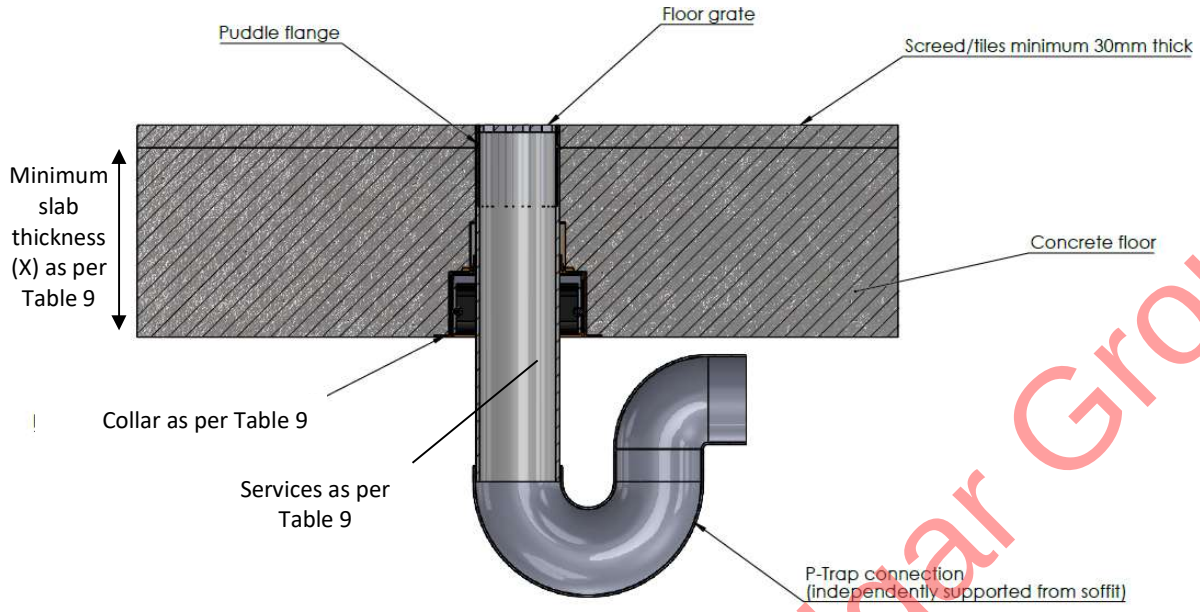

Figure 16: FW Cast-in collar with Floor waste pipes – P trap

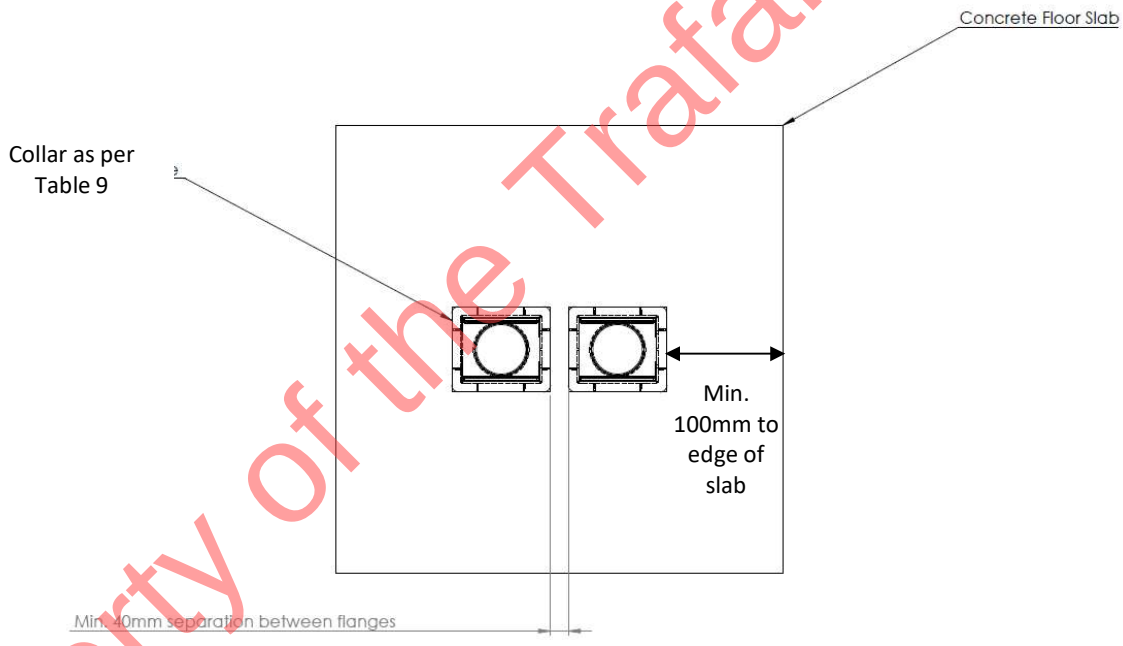

Figure 17: Spacing between adjacent penetrations confirmed to be 40mm (flange to flange)

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 10: Concrete slab with collars protecting PVC/uPVC stack pipes

Pipe nominal diameter (mm)	Collar	Construction Details	FRL	
			Minimum slab thickness (X)	
			≥150mm	≥175mm
40	CHC40-65/ CLC-40	Figures 1-5, 8-10a Tables 2, 6	-/180/180	-/240/240
50	CHC40-65/ CL-50		-/180/180	-/240/240
65	CHC40-65/ CLC-65		-/180/180	-/240/240
80	CHC80-100/ CLC-80		-/180/180	-/240/240
90	CHC80-100		-/180/180	-/240/240
100 or 100(SC)	CHC80-100/ CLC-100		-/180/180	-/240/240

Table 11: Concrete slab with collars protecting HDPE (PE80, SDR 26) stack pipes

Pipe nominal diameter (mm)	Collar	Construction Details	FRL	
			Minimum slab thickness (X)	
			≥150mm	≥175mm
50	CHC40-65/ CLC-50	Figures 1-5, 8-10a Tables 3, 6	-/180/180	-/240/240
56	CHC40-65/ CLC-50		-/180/180	-/240/240
60	CHC40-65/ CLC-65		-/180/180	-/240/240
75	CHC40-65/ CLC-65		-/180/180	-/240/240
90	CHC80-100		-/180/180	-/240/240
100	CHC80-100/ CLC-100		-/180/180	-/240/240

Table 12: Concrete slab with collars protecting copper pipes

Type B copper pipes	Collar	Construction Details	FRL	
			Minimum slab thickness (X)	
			≥150mm	≥175mm
DN32	CHC40-65/ CLC-40	Figures 1-3, 5-10 Tables 4, 6	-/180/120	-/240/120
DN40	CHC40-65/ CLC-40		-/180/120	-/240/120
DN50	CHC40-65/ CLC-50		-/180/120	-/240/120
DN50	CHC80-100/ CLC-50		-/180/120	-/240/120
DN65	CHC80-100/ CLC-65		-/180/120	-/240/120
DN80	CHC80-100/ CLC-80		-/180/120	-/240/120
DN100	CHC80-100/ CLC-100		-/180/120	-/240/120

Table 13: Concrete slab with collars protecting steel pipes

Type B copper pipes	Collar	Construction Details	FRL	
			Minimum slab thickness (X)	
			≥150mm	≥175mm
NB32	CHC40-65/ CLC-40	Figures 1-3, 5-10 Tables 5, 6	-/180/120	-/240/120
NB40	CHC40-65/ CLC-50		-/180/120	-/240/120
NB50	CHC40-65/ CLC-65		-/180/120	-/240/120
NB50	CHC80-100/ CLC-50		-/180/120	-/240/120
NB65	CHC80-100/ CLC-65		-/180/120	-/240/120
NB80	CHC80-100/ CLC-80		-/180/120	-/240/120
NB100	CHC80-100/ CLC-100		-/180/120	-/240/120

Table 14: Concrete slab with collars protecting paircoil bundle

Service	Number of services	Collar	Construction Details	FRL	
				Minimum slab thickness (X)	
				≥150mm	≥175mm
1 x installation of pair coil bundle: 3/8 + 3/4 paircoil with 19mm thick Arden Superpair FR insulation 1 x 25mm diameter (1.5mm wall thickness) Aussie Duct aircon and refrigeration drainpipe	Up to 2 x installation of paircoil bundles	CHC80-100	Figures 1, 8, 9, 11 Tables 7 and 8	-/180/90	-/180/90
	Up to 2 x installation of paircoil bundles		Figures 1, 8, 9, 12 Tables 7 and 8	-/180/120	-/180/120
	1 x installation of paircoil bundle	CHC40-65	Figures 1, 8, 9, 12 Tables 7 and 8	-/180/120	-/180/120

Table 15: Concrete slab with collars protecting various plastic floor waste pipes

Pipe Material	Pipe nominal diameter (mm)	Collar	Config. under the slab	Other construction Details	FRL	
					Minimum slab thickness (X)	
					≥150mm	≥175mm
PVC (SC) (SN6)	100	Low-Cast FW Collar	Figure 11	Figures 13, 14, 15, 16, 17 Table 9	-/180/180	-/240/240
		High-Cast FW Collar	Figure 11		-/180/180	-/240/180
		Low-Cast FW Collar	Figure 12		-/180/120	-/240/120
		High-Cast FW Collar	Figure 12		-/180/180	-/240/180
HDPE (PE 100, SDR 26)	100	Low-Cast FW Collar	Figure 11		-/180/180	-/240/240
	100	Low-Cast FW Collar	Figure 12		-/180/180	-/240/240
Rehua Raupiano Plus PP	100	Low-Cast FW Collar	Figure 11		-/180/180	-/240/240
DBlue	100	Low-Cast FW Collar	Figure 11		-/180/180	-/240/240

6 Direct Field of Application of Results

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

7 Requirements

Where concrete slabs are specified in this report, it is required that they be designed, tested or assessed as a separating element for the required FRL when including the service penetration specified in Section 5.

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 September 2027. 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. FSP 1050B

On 8 March 2004, CSIRO North Ryde conducted a fire-resistance test in accordance with AS 1530.4 – 1997 on a 150 mm thick reinforced concrete slab penetrated by four uPVC pipes protected by cast-in fire collars. The details of the relevant penetrations and their performances are summarised in Table A1.

A.2. FSP 1093B

On 1 November 2004, CSIRO North Ryde conducted a fire-resistance test in accordance with AS 1530.4 – 1997 on a 150 mm thick reinforced concrete slab penetrated by four HDPE pipes protected by intumescent fire collars, three cast-in and one retro-fitted to the underside of a concrete slab. The details of the relevant penetrations and their performances are summarised in Table A1.

A.3. The relevance of tests in accordance with AS 1530.4-1997 to AS 1530.4-2014

The referenced fire resistance tests FSP 1050B and FSP 1093B were conducted in accordance with AS 1530.4– 1997, 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 1530.4-1997. The specified specimen heating rate in AS 1530.4-1997 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, not less than 10°C nor more than 40°C.

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

The heating regimes in AS 1530.4–1997 and AS 1530.4–2014 vary in that the former is an expression of the temperature rise in the furnace above an initial ambient temperature, and the latter although similar, assumes that the initial furnace temperature (T_0) is 20°C irrespective of the actual ambient temperature. A test conducted in accordance with AS 1530.4–1997 on a warm day (ambient temperature above 20°C) could, therefore, be slightly more onerous than that in accordance with AS 1530.4–2014.

The parameters outlining the accuracy of control of the furnace temperature in AS 1530.4– 2014 and AS 1530.4–1997 are not appreciably different.

Furnace Pressure

A.13.1.2 The furnace pressure level and control parameters in AS 1530.4–2014 and AS 1530.4–1997 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

AS 1530.4-2014 deems integrity failure to have occurred upon collapse, sustained (10 seconds) flaming, ignition of an applied cotton pad or if a 6mm gap gauge can protrude into the furnace and can be moved 150mm along the gap (not applicable at the sill), or if a 25mm gap gauge can protrude into the furnace.

AS 1530.4-1997 deems integrity failure to occur upon collapse, the development of cracks, fissures, or other openings through which flames or hot gases can pass.

The integrity requirements for AS 1530.4-2014 are different after the formation of gaps on the specimen that would require the application of the cotton pad tests. Prior to the formation of gaps, the criteria are not appreciably different.

It is possible for a gap or opening to form which does not allow a straight line of sight into the furnace but allows sufficient passage of hot gases to ignite a cotton wool pad. Nevertheless, such circumstances did not occur according to the observations of the referenced specimens in the reference tests.

Insulation

The positions of thermocouples and failure criteria for insulation in AS 1530.4-2014 and AS 1530.4-1997 are not appreciably different.

Specimen Size, Support and End Conditions

The AS 1530.4- 2014 standard prescribes that, for plastic pipes, the penetrating service shall extend a minimum of 500mm past the separating element into the furnace and a minimum of 2000mm past the separating element away from the furnace. The AS 1530.4- 1997 standard has the same minimum 2000mm extension requirement away from the furnace but prescribes only a 100mm minimum extension into the furnace. It is confirmed that some of the referenced test specimens did not meet the AS 1530.4- 2014 requirement for the length of extension into the furnace.

Since the pipes are plastic and have a corresponding low melting temperature, the length of the pipe extending into the furnace is not considered important, as this length will melt away very early in the test. The important aspect of specimen size is the length of the pipe extending away from the furnace, a requirement that is identical between the AS 1530.4- 1997 and AS 1530.4- 2014 standards.

Application of referenced test data to AS 1530.4-2014

The minor variations in the furnace heating regime are not expected to have a significant effect on the outcome of the referenced fire resistance test. The differences in integrity criteria and size requirements have been concluded to be insignificant for the specimen configurations in the reference tests.

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

A.4. FSP 1358B

On 19 May 2009, CSIRO North Ryde conducted a fire-resistance test in accordance with AS 1530.4 – 2005 on a 150 mm thick reinforced concrete slab penetrated by four PVC pipes protected by cast-in fire collars and with elbow fitting within the collar. The details of the relevant penetrations and their performances are summarised in Table A1.

A.5. The relevance of AS 1530.4 -2005 test data to AS 1530.4 - 2014

The referenced fire resistance test FSP 1358B was 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 test would not have been appreciably different if they were undertaken in accordance with AS 1530.4-2014.

A.6. FRT 210024

On 24 February 2021, Warringtonfire VIC, conducted a fire-resistance test in accordance with AS 1530.4 – 2014 on a 150mm thick floor slab system protected by various cast-in collars. The details of the relevant penetrations and their performances are summarised in Table A2.

A.7. FRT 210025

On 9 April 2021, Warringtonfire VIC, conducted a fire-resistance test in accordance with AS 1530.4 – 2014 on a 150mm thick floor slab system protected by various cast-in collars and fire collars. The details of the relevant penetrations and their performances are summarised in Tables A3 and A4.

A.8. FSP 2199

On 10 May 2021, CSIRO North Ryde conducted a fire-resistance test in accordance with AS 1530.4 – 2014 on three Trafalgar Group fire collars protecting a 150-mm thick concrete floor slab penetrated by three services. The details of the relevant penetration and its performance is summarised in Table A2.

A.9. FSP 2245

On 25 November 2021, CSIRO North Ryde conducted a fire-resistance test in accordance with AS 1530.4 – 2014 on Trafalgar Group Fyrechoke cast-in collars protecting a 150mm thick concrete slab penetrated by four stack pipes. The details of the relevant penetrations and their performance are summarised in Table A1.

A.10. FSP 2281

On 26 April 2022, CSIRO North Ryde conducted a fire-resistance test in accordance with AS 1530.4 – 2014 on Trafalgar Group Fyrechoke cast-in collars protecting a 150mm thick concrete slab penetrated by four stack pipes. The details of the relevant penetrations and their performance are summarised in Table A1.

A.11. Summary of relevant test data

Table A1: summary of test data for plastic stack pipes

Report	Pen. #	Collar Type	Pipe Material	Pipe ND (mm)	Pipe OD (mm)	Pipe wall Thickness (mm)	Unexposed side	Annular gap (mm)	Integrity/ insulation (min.)
FSP 1050B	A	CHC80-100	uPVC DWV Foam Pipe	100	110	3	Collar flash with slab (no sealant)	6	-/240NF /240NF
FSP 1050B	B	CHC40-65	uPVC	40	43	2	Collar flash with slab (no sealant)	19.5	-/240NF /240NF
FSP 1050B	C	CHC80-100	uPVC	80	83	3	Collar flash with slab (no sealant)	19.5	-/240NF /240NF
FSP 1050B	D	CHC40-65	uPVC	65	69	3	Collar flash with slab (no sealant)	6.5	-/240NF/ 240NF
FSP 1093B	C	CHC40-65	HDPE	50	50	N/A	Collar above slab (no sealant)	6	-/240NF /9(pipe)
FSP 2245	2	CHC40-65	uPVC	65	69	2.9	Collar 100mm above slab Sealant between services and between collar and services to 10mm deep	5.5	-/241NF /241NF
FSP 2245	3	CHC80-100	uPVC	80	82.5	2.9	Collar 100mm above slab Sealant between services and between collar and services to 10mm deep	17.75	-/241NF /241NF
FSP 2245	4	CLC100	uPVC-SC	100	110	3	Cast-in with no gap	0	-/241NF /241NF
FSP 2281	1	CLC40	uPVC	40	43.2	2.2	Cast-in with no gap	0	-/241NF /241NF
FSP 2281	3	CHC40-65	uPVC	50	56	2.2	Collar 100mm above slab and sealed with 10mm deep Fyreflex sealant	12	-/241NF /241NF
FSP 2281	4	CHC40-65	uPVC	40	43	2.2	Collar 100mm above slab and sealed with 10mm deep Fyreflex sealant	18.5	-/241NF /241NF
FSP 1358B	1	CHC80-100	uPVC + socket	100	100	6.7	Collar flash with slab and sealed with Ramset Blazebrake acrylic sealant	10	-/241NF /241NF
FSP 1358B	2	CHC80-100	uPVC + socket	80	80	6.1	Collar flash with slab and sealed with Ramset Blazebrake acrylic sealant	20	-/241NF /241NF

Report	Pen. #	Collar Type	Pipe Material	Pipe ND (mm)	Pipe OD (mm)	Pipe wall Thickness (mm)	Unexposed side	Annular gap (mm)	Integrity/ insulation (min.)
FSP 1358B	3	CHC40-65	uPVC + socket	65	65	5.6	Collar flash with slab and sealed with Ramset Blazebrake acrylic sealant	21	-/241NF /241NF
FSP 1358B	4	CHC40-65	uPVC + socket	40	40	4.2	Collar flash with slab and sealed with Ramset Blazebrake acrylic sealant	33.5	-/241NF /241NF
FRT 210025	F	CHC80-100	uPVC SN6/SC	100	110	4	Collar 100mm above slab Sealant between services and between collar and services to 10mm deep	4.5	-/241NF /241NF
FSP 1093B	A	CHC40-65	HDPE PE80	75	75	3	Collar above slab (no sealant)	3.5	-/240NF /240NF
FSP 1093B	B	CHC80-100	HDPE PE80	100	110	4.3	Collar above slab (no sealant)	6	-/240NF /240NF
FSP 2245	1	CHC80-100	HDPE Akatherm SDR 26 PE 80	110	111	4.2	Collar 100mm above slab Sealant between services and between collar and services to 10mm deep	3.5	-/241NF /241NF

Table A2: Summary of test data for Paircoil installation

Report	Pen. #	Collar Type	Paircoil specification	Unexposed side	Integrity/ insulation (min.)
FRT 210025	E	CHC80-100	2 x 3/8 + 3/4 paircoil with 19mm thick Arden Superpair FR insulation 1 x 25mm diameter (1.5mm wall thickness) Aussie Duct aircon and refrigeration drainpipe 2 x CAT 6 cable (5mm diameter) 2 X power(3C+E) cable (5mm diameter)	Collar 100mm above slab Sealant between services and between collar and services to 10mm deep	-/238NF /114(3C+E cable)

Table A3: summary of test data for plastic floor waste pipes

Report	Pen. #	Collar Type	Pipe Material	Pipe ND (mm)	Pipe OD (mm)	Pipe wall Thickness (mm)	Unexposed side	Config.	Integrity/ insulation (min.)
FRT 210024	C	FW-100 High Cast-in collar	PVC-SC SN 6	100	110	4	100mm Chrome grate	P trap	-/241NF/ 204 (grate)
FRT 210024	F	FW-100 Low Cast-in collar	PVC-SC SN 6	100	110	4	100mm Chrome grate	P trap	-/241NF/ 138 (grate)
FSP 2199	1	FW-100 Low Cast-in collar	PVC-SC SN 6	100	110	3.5	Chrome plated brass grate	4 way - Floor waste gully	-/241NF /241NF
FRT 210024	D	FW-100 Low Cast-in collar	Geberit HDPE (PE 100 SDR 26)	100	110	5	150mm Brass grate	P trap	-/241NF /240NF
FSP 2199	2	FW-100 Low Cast-in collar	Dblue	110	110	3.4	Chrome plated brass grate	4 way - Floor waste gully	-/241NF /241NF
FSP 2199	3	FW-100 Low Cast-in collar	Rehua Raupiano Plus PP-MD	110	110	3.4	Chrome plated brass grate	4 way - Floor waste gully	-/241NF /241NF

Table A4: summary of test data for metal pipes

Report	Pen. #	Collar Type	Pipe Material	Pipe ND (mm)	Pipe OD (mm)	Pipe wall Thickness (mm)	Unexposed side	Annular gap	Integrity/ insulation (min.)
FRT 210025	A	CHC80 -100	Copper	100	101.6	1.63	10mm deep Fyreflex sealant in the gap, Uniguard at 600mm height and 30mm from pipe	8.7	-/241NF /149 (pipe)
FRT 210025	C	CHC80 -100	Copper	50	50.8	1.22	300mm Twrap, 15mm into the collar, finished with 30x30mm Fyreflex fillet	34.1	-/241NF /156(pipe)

Appendix B Analysis of Variations

B.1 Variation to collars body and components

The proposed collar shall be Cast-In collars tested in Table 1 and subject to the following variations:

- Include various changes to shell dimensions for various collars as outlined below
- Vary the intumescent material to that tested in FSP 2245 and FSP 2281
- Inclusion of the services listed in Tables 2-5, 7 and 9 when protected CLC and CHC collars

CHC vs CLC collars

The differences in the proposed CLC collar as tested in FSP 2245 compared to CHC collar counter parts as tested in FSP 2245 are:

- Decrease in collar height from 250mm to 80mm
- Absence of rubber seal
- Smaller neck profile

The proposed CLC collar has the same intumescent strip and inner shell dimensions as the proposed CHC collar. Therefore, it is considered the minor changes to the collar height and profile will not have any effect on the performance of the collar.

Based on the above, it is expected that the test result for the CHC 40-65 collar can be applied to CLC 40, CLC 50 and CLC 65 collar and vice versa for the test specimens referenced in Appendix A of this report.

Based on the above, it is expected that the test result for the CHC 80-100 collar can be applied to CLC 80 and CLC 100 collar and vice versa for the test specimens referenced in Appendix A of this report.

CHC 40-65

The differences in the proposed CHC 40-65 collar as tested in FSP 2281 compared to previously tested versions are:

- Decrease of collar inner neck diameter from 82mm to 80mm
- Decrease of collar inner base diameter from 107mm to 105mm
- Increase in collar height from 150mm to 250mm
- Change in formulation and size of the intumescent strip

It is considered the minor changes to the inner diameter of the collar shell and an increase in collar height are not expected to have any effect on the performance of the collar.

With reference to FSP 1093B, the recorded intumescent strip size for the CHC 40-65 collar was 23mm x 12mm while the intumescent density was 1411kg/m^3. The proposed CHC 40-65 collar tested in FSP 2281 comprises a 40mm x 10mm intumescent strip and the intumescent density of nominally 730kg/m^3. It is expected that the changes made to the intumescent strip will affect the performance of the specimen and these are discussed below.

With reference to FSP 1050B, specimen B comprised a 40mm diameter PVC pipe protected with the old CHC 40-65 collar. The closure time of the collar on the pipe was around 8 minutes, leading to an initial peak of 100^{o}C temperature rise on the pipe and a final pipe temperature rise of 68^{o}C. There was no integrity or insulation failure observed for up to 240 minutes duration of the test.

With reference to FSP 2281, specimen 4 comprised a 40mm diameter PVC pipe protected with the newer CHC 40-65 collar. The closure time of the collar on the pipe was around 10 minutes, leading to an initial peak of 150^{o}C temperature rise on the pipe and a final pipe temperature rise of 69^{o}C. There was no integrity or insulation failure observed for up to 241 minutes duration of the test.

The significance of the above two referenced test specimens demonstrated that the changes made to the intumescent strip did slightly delay the closure time of the pipe and thus increase the peak temperature of the pipe before collar closure. However, the intumescent was able to maintain sufficient strength to remain in place for up to 240 minutes and allow the final pipe temperature rise to be similar to when protected with the older collar

Based on the above, it is expected that the test result for the older CHC 40-65 collar can be applied to the newer CHC 40-65 collar for the PVC pipe test specimens referenced in Appendix A of this report.

CHC 80-100, CLC 80 and CLC 100 collar

The differences in the proposed CHC 80-100 collar as tested in FSP 2245 compared to their older versions are:

- Decrease of collar inner neck diameter from 122mm to 118mm
- Decrease of collar inner base diameter from 120mm to 118mm
- Increase in collar height from 150mm to 250mm
- Change in formulation and size of the intumescent strip

It is considered the minor changes to the inner diameter of the collar shell and an increase in collar height are not expected to have any effect on the performance of the collar.

With reference to FSP 1050B, the recorded intumescent strip size for the CHC 80-100 collar was 30mm x 20mm. The proposed CHC 80-100 collar tested in FSP 2245 comprises two layers of 40mm x 10mm intumescent strip and the intumescent density of nominally 730kg/m^3. It is expected that the changes made to the intumescent strip will affect the performance of the specimen and this is discussed below.

With reference to FSP 1050B, specimen A comprised a 100mm diameter PVC pipe protected with the old CHC 80-100 collar. The closure time of the collar on the pipe was around 11 minutes, leading to an initial peak of 173^{o}C temperature rise on the pipe and a final pipe temperature rise of 66^{o}C. There was no integrity or insulation failure observed for up to 240 minutes duration of the test.

With reference to FSP 2245, specimen 4 comprised a 100mm diameter PVC pipe protected with the newer CLC 100 collar (similar to the CHC80-100 collar as discussed above). The closure time of the collar on the pipe was around 11 minutes, leading to an initial peak of 160^{o}C temperature rise on the pipe and a final pipe temperature rise of 75^{o}C. There was no integrity or insulation failure observed for up to 241 minutes duration of the test.

With reference to FSP 1050B, specimen C comprised an 80mm diameter PVC pipe protected with the old CHC 80-100 collar. The closure time of the collar on the pipe was around 7 minutes, leading to an initial peak of 124^{o}C temperature rise on the pipe and a final pipe temperature rise of 63^{o}C. There was no integrity or insulation failure observed for up to 240 minutes duration of the test.

With reference to FSP 2245, specimen 3 comprised an 80mm diameter PVC pipe protected with the newer CHC80-100 collar. The closure time of the collar on the pipe was around 11 minutes, leading to an initial peak of 134^{o}C temperature rise on the pipe and a final pipe temperature rise of 43^{o}C. There was no integrity or insulation failure observed for up to 241 minutes duration of the test.

The significance of the above four referenced test specimens demonstrated that the changes made to the intumescent strip did slightly delay the closure time of the pipe and thus increase the peak temperature of the pipe before collar closure. However, the intumescent was able to maintain sufficient strength to remain in place for up to 240 minutes and allow the final pipe temperature rise to be similar to when protected with the older collar

Based on the above, it is expected that the test result for the older CHC 80-100 collar can be applied to the newer CHC 80-100 and CLC 80 and CLC 100 collar for the PVC pipe test specimens referenced in Appendix A of this report.

HDPE (PE80) pipes with newer collars

The proposed construction comprises the protection of proposed HDPE (PE80) pipes with the newer CHC 80-100 collar.

With reference to FSP 1093B, specimen B comprised a 110mm OD HDPE (PE80) pipe protected with the old CHC 80-100 collar. The closure time of the collar on the pipe was around 12 minutes, leading to an initial peak of 136°C temperature rise on the pipe. There was no integrity or insulation failure observed for up to 240 minutes duration of the test.

With reference to FSP 2245, specimen 4 comprised a 110mm OD HDPE (PE80) pipe protected with the newer CLC 100 collar (similar to the CHC80-100 collar as discussed above). The closure time of the collar on the pipe was around 12 minutes, leading to an initial peak of 127°C temperature rise on the pipe. There was no integrity or insulation failure observed for up to 241 minutes duration of the test

The significance of the above two referenced test specimens demonstrated that the changes made to the intumescent strip did not hinder the collar from being able to close off the 110mm OD HDPE(PE80) pipe, allowing the pipe's final temperature rise to be similar to when protected with the previously tested collar.

Based on the above, it is expected that the test results in Appendix A for the previously tested CHC 40-65 and CHC 80-100 collars can be applied to the newer CHC 40-65 collar and CHC 80-100, CLC 80 and CLC 100 collar respectively for the HDPE(PE80) pipes.

B.2 Variations in pipe material and size

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(PE80) stack pipes as shown in Tables 2 and 3.
- The inclusion of copper and steel pipes as shown in Tables 4 and 5.
- The inclusion of paircoil bundles as shown in Table 7.
- The inclusion of AUS Sandwich Core (SC) PVC and HDPE (PE 100, SDR 26) floor waste pipes as shown in Table 9.

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 for each collar type 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 120mm and the OD of the smallest pipe cannot be less than 40-mm.

This assessment refers to the requirements of this clause for the assessed pipes between 40mm and 110mm for pipes made from various materials and paircoil bundle services. These variations will be discussed below.

B2.1 PVC stack pipes protected with CHC and CLC collars

40-65mm PVC stack pipes without fitting

The proposed construction comprises a CHC 40-65 collar and CLC 40, CLC 50 and CLC65 collar protecting 40mm, 50mm and 65mm PVC stack pipes penetrating through 150mm and 175mm thick slabs.

Table B1: Test data summary for 40mm to 65mm PVC/PVC stack pipes

Report	Pen. #	Collar Type	Pipe Material	Pipe ND (mm)	Pipe wall Thickness (mm)	Unexposed side	Annular gap (mm)	Integrity/ insulation (min.)
FSP 1050B	B	CHC40-65	uPVC	40	2	Collar flash with slab (no sealant)	19.5	-/240NF /240NF
FSP 1050B	D	CHC40-65	uPVC	65	3	Collar flash with slab (no sealant)	6.5	-/240NF/ 240NF
FSP 2281	1	CLC40	uPVC	40	2.2	Cast-in with no gap	0	-/241NF /241NF
FSP 2281	4	CHC40-65	uPVC	40	2.2	Collar 100mm above slab and sealed with 10mm deep Fyreflex sealant	18.5	-/241NF /241NF
FSP 2281	3	CHC40-65	uPVC	50	2.2	Collar 100mm above slab and sealed with 10mm deep Fyreflex sealant	12	-/241NF /241NF
FSP 2245	2	CHC40-65	uPVC	65	2.9	Collar 100mm above slab Sealant between services and between collar and services to 10mm deep	5.5	-/241NF /241NF
FSP 1358B	4	CHC40-65	uPVC + socket	40	4.2	Collar flash with slab and sealed with Ramset Blazebrake acrylic sealant	33.5	-/241NF /241NF
FSP 1358B	3	CHC40-65	uPVC + socket	65	5.6	Collar flash with slab and sealed with Ramset Blazebrake acrylic sealant	21	-/241NF /241NF

As discussed previously, the old CHC 40-65 collar data in FSP 1050B applies to the proposed CHC 40-65 as tested in FSP 2245.

Also as discussed previously, the proposed CHC 40-65 collar is similar to the proposed CLC40, CLC50 and CLC65 collar. Therefore the results of the CHC 40-65 collar and CLC 40 collar can be analysed together as the same collar behaviour.

With reference to test data summarised in Table B1, 40mm, 50mm and 65mm PVC pipes penetrated 150mm thick concrete slabs and were protected with either a CHC 40-65 collar or a CLC 40 collar.

It is observed that these specimens all were able to maintain integrity for up to 240 minutes without failure.

The proposed increase in slab thickness to 175mm slab is thicker than the tested 150mm thick slab and thus would have more heat sink effect than the 150mm slab. It is therefore expected that the pipes installed in a 175mm thick slab will be able to maintain insulation for up to 240 minutes when protected with the proposed collars.

Confidence in the ability of the 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, the prequalification testing of the uPVC pipe sizes between 40mm, 50mm and 65mm was met for the proposed collars. Therefore, these pipes will be able to maintain integrity and insulation performance of up to 180 minutes in 150mm thick slabs and 240 minutes in 175mm thick slabs when protected with the proposed collars.

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.

PVC stack pipes with fittings

The proposed variation comprises PVC pipe with nominal diameters of 40mm, 50mm and 65mm and fitting be installed in 150 and 175mm thick slabs and protected with the proposed CHC 40-65, CLC 40, CLC50 or CLC65 collar.

The proposed variation to include fitting/coupling changes the wall thickness of the PVC pipe which may affect and or delay collar closure, and therefore the proposed pipes will be treated as a new pipe material.

With reference to test data summarised in Table B1, 40mm and 65mm PVC pipes with sockets penetrated 150mm thick concrete slabs and were protected with a CHC 40-65 collar. Both pipes were able to maintain integrity and insulation for up to 240 minutes.

It is expected the intermediate size of 50mm PVC pipe with socket will also be able to be close off by the CHC 40-65 collar and be able to maintain integrity and insulation for up to 240 minutes.

Based on the above, it is considered that the proposed variation will not detrimentally affect the integrity and insulation performance of the proposed construction 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.

80-100mm PVC stack pipes without fitting

The proposed construction comprises a CHC80-100 collar and CLC80, CLC100 collar protecting 80mm, 90mm and 100mm PVC stack pipes penetrating through 150mm and 175mm thick slabs.

Table B2: Test data summary for 80mm to 100mm PVC/PVC SC stack pipes

Report	Pen. #	Collar Type	Pipe Material	Pipe ND (mm)	Pipe wall Thickness (mm)	Unexposed side	Annular gap (mm)	Integrity/ insulation (min.)
FSP 1050B	C	CHC80-100	uPVC	80	3	Collar flash with slab (no sealant)	19.5	-/240NF /240NF
FSP 1050B	A	CHC80-100	uPVC DWV Foam Pipe	100	3	Collar flash with slab (no sealant)	6	-/240NF /240NF
FSP 2245	3	CHC80-100	uPVC	80	2.9	Collar 100mm above slab Sealant between services and between collar and services to 10mm deep	17.75	-/241NF /241NF
FSP 2245	4	CLC100	uPVC-SC	100	3	Cast-in with no gap	0	-/241NF /241NF
FSP 1358B	2	CHC80-100	uPVC + socket	80	6.1	Collar flash with slab and sealed with Ramset Blazebrake acrylic sealant	20	-/241NF /241NF
FSP 1358B	1	CHC80-100	uPVC + socket	100	6.7	Collar flash with slab and sealed with Ramset Blazebrake acrylic sealant	10	-/241NF /241NF
FRT 210025	F	CHC80-100	uPVC SN6/SC	100	4	Collar 100mm above slab Sealant between services and between collar and services to 10mm deep	4.5	-/241NF /241NF

As discussed previously, the old CHC80-100 collar data in FSP 1050B is applicable to the proposed CHC80-100 as tested in FSP 2245.

Also as discussed previously, the proposed CHC80-100 collar is similar to the proposed CLC80, CLC100 collar. Therefore, the results of the CHC80-100 collar and CLC100 collar can be analysed together as the same collar behaviour.

With reference to test data summarised in Table B2, 80mm and 100mm PVC pipes penetrated 150mm thick concrete slabs and were protected with either a CHC80-100 collar or a CLC100 collar.

It is observed that these specimens all were able to maintain integrity for up to 240 minutes without failure.

The proposed increase in slab thickness to 175mm slab is thicker than the tested 150mm thick slab and thus would have more heat sink effect than the 150mm slab. It is therefore expected that the

pipes installed in a 175mm thick slab will be able to maintain insulation for up to 240 minutes when protected with the proposed collars.

Confidence in the ability of the 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, the prequalification testing of the uPVC pipe sizes between 80mm and 100mm was met for the proposed collars. Therefore, these pipes will be able to maintain integrity and insulation performance of up to 180 minutes in 150mm thick slabs and 240 minutes in 175mm thick slabs when protected with the proposed collars.

It is expected the intermediate size of 90mm PVC pipe will also be able to be close off by the CHC 80-100 collar and be able to maintain integrity and insulation for up to 240 minutes.

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.

PVC stack pipes with fittings

The proposed variation comprises PVC pipe with nominal diameters of 80mm, 90mm and 100mm with pipe fitting installed in 150 and 175-mm thick slabs and protected with the proposed CHC80-100, CLC80 or CLC100 collar.

The proposed variation to include fitting/coupling changes the wall thickness of the PVC pipe which may affect and or delay collar closure, and therefore the proposed pipes will be treated as a new pipe material.

With reference to test data summarised in Table B2, 80mm and 100mm PVC pipes with sockets penetrated 150mm thick concrete slabs and were protected with a CHC80-100 collar. Both pipes were able to maintain integrity and insulation for up to 240 minutes.

It is expected the intermediate size of 90mm PVC pipe with a socket will also be able to be close off by the CHC80-100 collar and be able to maintain integrity and insulation for up to 240 minutes.

Based on the above, it is considered that the proposed variation will not detrimentally affect the integrity and insulation performance of the proposed construction 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.

Collar neck configuration above the slab

The proposed variation comprises the CHC collars with the neck above the slab as shown in Figure 4 and flush with the slab as shown in Figure 3 when protecting PVC stack pipes.

With reference to Tables B1 and B2, it is observed that the pipes of each size with the proposed cast-in collar were able to maintain integrity and insulation for up to 240 minutes when the collar is either flush or protrudes above the slab.

Based on the above, it is considered that the proposed variation will not detrimentally affect the integrity and insulation performance of the proposed construction 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.

B2.2 HDPE stack pipes protected with CHC and CLC collars

40-65mm HDPE stack pipes without fitting

The proposed construction comprises a CHC 40-65 collar and CLC 50, CLC65 collar protecting 50mm, 56mm, 65mm and 75mm HDPE stack pipes penetrating through 150mm and 175mm thick slabs with collar neck protruding above the slab as per Figure 4.

Table B3: Test data summary for 40mm to 65mm PVC/PVC stack pipes

Report	Pen. #	Collar Type	Pipe Material	Pipe OD (mm)	Pipe wall Thickness (mm)	Unexposed side	Annular gap (mm)	Integrity/ insulation (min.)
FSP 1093B	C	CHC40-65	HDPE	50	N/A	Collar above slab (no sealant)	6	-/240NF /9(pipe)
FSP 1093B	A	CHC40-65	HDPE PE80	75	3	Collar above slab (no sealant)	3.5	-/240NF /240NF
FSP 1093B	B	CHC80-100	HDPE PE80	110	4.3	Collar above slab (no sealant)	6	-/240NF /240NF
FSP 2245	1	CHC80-100	HDPE Akatherm PE 80 SDR 26	111	4.2	Collar 100mm above slab Sealant between services and between collar and services to 10mm deep	3.5	-/241NF /241NF

As discussed previously, the old CHC 40-65 collar data is applicable to the proposed CHC 40-65 collar. With reference to test data summarised in Table B3, 50mm and 75mm HDPE pipes penetrated 150mm thick concrete slabs and were protected with a CHC 40-65 collar. The 75mm HDPE pipe was able to maintain integrity and insulation for up to 240 minutes.

However, the 50mm HDPE pipe specimen failed insulation at 9 minutes when the collar did not close in time and allowed hot gas from the furnace to travel from the collar shell up the pipe wall and heat up the thermocouple on the pipe. This is evident in the deformation and melting of the collar observed at 5-8 minutes. When the collar closed at 9 minutes, the temperature of the pipe decreased and did not reach insulation failure for the remaining 240 minutes duration of the test.

The proposed construction comprises raising the collar neck above the slab and sealing off the gap with sealant. This will increase the distance to the furnace and also hinder hot gas from heating up the thermocouple from outside the pipe before the collar closes and thus allow the pipe to maintain insulation for up to 240 minutes.

It is expected the intermediate size of 65mm HDPE pipe will also be able to be closed off by the CHC 40-65 collar and be able to maintain integrity and insulation for up to 240 minutes.

Also as discussed previously, the proposed CHC 40-65 collar is similar to the proposed CLC50, CLC65 collar. Therefore, the results of the CHC 40-65 collar are also applicable to CLC50 and CLC65 collars for the proposed pipe sizes.

Based on the above, it is considered that the proposed variation will not detrimentally affect the integrity and insulation performance of the proposed construction 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.

80-100mm HDPE stack pipes without fitting

The proposed construction comprises a CHC80-100 collar protecting 90mm and 100mm HDPE stack pipes penetrating through 150mm and 175mm thick slabs with collar neck protruding above the slab as per Figure 4.

As discussed previously, the old CHC80-100 collar data is applicable to the proposed CHC80-100 collar.

With reference to test data summarised in Table B3, 100mm HDPE pipes penetrated 150mm thick concrete slabs and were protected with a CHC80-100 collar, and were able to maintain integrity and insulation for up to 240 minutes.

The proposed 90mm HDPE pipe protected with a CHC80-100 collar will have similar gaps around the pipe as the tested 50mm HDPE pipe protected with a CHC 40-65 collar. It is expected that likewise, the intumescent in the CHC80-100 collar will be able to close off the 90mm HDPE pipe and allow it to maintain integrity and insulation for up to 240 minutes.

As discussed previously, the proposed CHC80-100 collar is similar to the proposed CLC100 collar. Therefore, the results of the CHC80-100 collar are also applicable to the CLC100 collar for the proposed 100mm HDPE pipe.

Based on the above, it is considered that the proposed variation will not detrimentally affect the integrity and insulation performance of the proposed construction 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.

B2.3 Metal pipes protected with CHC and CLC collars

The proposed construction comprises the installation of copper or steel pipes in 150mm and 175mm thick slabs, protected with CHC or CLC collars and with either Twrap or Uniguard as per Tables 4 and 5.

Table B4: Test data summary for metal pipes

Report	Pen. #	Collar Type	Pipe Material	Pipe OD (mm)	Pipe wall Thickness (mm)	Unexposed side	Annular gap	Integrity/ insulation (min.)
FRT 210025	A	CHC80 -100	Copper	101.6	1.63	10mm deep Fyreflex sealant in the gap, Uniguard at 600mm height and 30mm from pipe	8.7	-/241NF /149 (pipe)
FRT 210025	C	CHC80 -100	Copper	50.8	1.22	300mm Twrap, 15mm into the collar, finished with 30x30mm Fyreflex fillet	34.1	-/241NF /156(pipe)

With reference to Table B4, it demonstrated that the CHC80-100 collar when heated can activate and close off gaps around a 50mm and a 100mm copper pipe such that they were able to maintain integrity for up to 240 minutes.

Therefore, it is expected that the CHC80-100 collar and the corresponding CLC collars will also be able to allow the proposed intermediate sizes of 65mm and 80mm copper pipes to integrity for up to 240 minutes.

With reference to Table B4, it demonstrated that the 100mm copper pipe was able to maintain insulation for 149 minutes when the thermocouples on the pipe were kept at least 600mm from the slab with the use of a 600mm tall Uniguard.

The proposed smaller 65mm and 80mm copper pipe is expected to be cooler than the tested 100mm copper pipe and therefore expected to maintain insulation for up to 120 minutes when protected in the same manner.

The proposed 32mm, 40mm and 50mm copper pipe protected with a CHC40-65 collar will have similar gaps around the pipe as the tested 50mm and 100mm copper pipe protected with a CHC 80-100 collar. It is expected that likewise, the intumescent in the CHC40-65 collar will be able to close off the 32mm, 40mm and 50mm copper pipe and allow it to maintain integrity for up to 240 minutes.

Confidence is found in the intumescent in CHC40-65 and CLC40 collars able to remain in place for up to 240 minutes when protecting various sizes of PVC pipes as discussed in the sections above.

With reference to Table B4, it demonstrated that the 50mm copper pipe was able to maintain insulation for 156 minutes when the thermocouples on the pipe were kept at least 300mm from the slab when the pipe was wrapped in 300mm long Twrap.

Therefore, it is expected that the 300mm long Twrap or the 600mm tall Uniguard will also be able to allow the proposed smaller and thus cooler copper pipes to insulation for up to 120 minutes.

The proposed steel pipes have a larger wall thickness, though with a much lower thermal conductivity compared to their copper pipe counter parts. Therefore, it is reasonable to apply the results of the copper pipes as discussed above to the proposed steel pipes.

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

B2.4 Paircoil bundle pipes protected with CHC collars

The proposed construction comprises the installation of paircoil bundles in 150mm and 175mm slabs, protected with CHC40-65 or CHC80-100 collars and protected with Twrap as per Table 7.

Table B5: Test data summary for Paircoil bundle

Report	Pen. #	Collar Type	Pipe Material	Unexposed side	Integrity/ insulation (min.)
FRT 210025	E	CHC80-100	2 x 3/8 + 3/4 paircoil with 19mm thick Arden Superpair FR insulation 1 x 25mm diameter (1.5mm wall thickness) Aussie Duct aircon and refrigeration drainpipe 2 x CAT 6 cable (5mm diameter) 2 X power(3C+E) cable (5mm diameter)	Collar 100mm above slab Sealant between services and between collar and services to 10mm deep	-/238NF /114(3C+E cable)

With reference to Table B5, it demonstrated that the CHC80-100 collar can close off gaps around two bundles of paircoil services such that it was able to maintain integrity for up to 238 minutes and insulation for up to 114 minutes.

The proposed inclusion of a 300mm Twrap will extend the path of conduction on the paircoil and the cables. Based on the performance of the Twrap with the tested 50mm copper pipe as discussed above, it is reasonable and conservative to expect that the proposed two paircoil bundles with 300mm Twrap will be able to maintain insulation for up to 120 minutes.

The proposed one paircoil bundle protected with a CHC40-65 collar will have similar gaps around the pipe as the tested two paircoil bundles protected with a CHC 80-100 collar. It is expected that likewise, the intumescent in the CHC40-65 collar will be able to close off the one paircoil bundle and allow it to maintain integrity for up to 180 minutes.

It is reasonable and conservative to expect that the inclusion of 300mm Twrap on the one paircoil will also allow it to maintain insulation for up to 120 minutes.

Based on the above, it is considered that the proposed construction will maintain integrity for up to 180 minutes and insulation for up to 90 and 120 minutes based on design when tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1 -2005.

B2.5 Floor waste pipes protected with FW-100 Low and FW-100 high Cast-in collars

Floor waste pipes

The proposed construction comprises an FW-100 High Cast-in collar or an FW-100 Low Cast-in collar protecting 100mm PVC floor waste pipes with P-trap or 4-way floor waste gully configuration penetrating through 150mm and 175mm thick slabs.

Table B6: Summary of tested and proposed floor waste pipe configurations

Report	Pen. #	Collar Type	Pipe Material	Pipe OD (mm)	Pipe wall Thickness (mm)	Unexposed side	Config.	Integrity/ insulation (min.)
FSP 2199	1	FW-100 Low Cast-in collar	PVC-SC SN 6	110	3.5	Chrome plated brass grate	4 way - Floor waste gully	-/241NF /241NF
Proposed		FW-100 High Cast-in collar	PVC-SC SN 6	110	3.5	Chrome plated brass grate	4 way - Floor waste gully	NA
FRT 210024	F	FW-100 Low Cast-in collar	UPVC - SC	110	4	100mm Chrome grate	P trap	-/241NF/ 138 (grate)
FRT 210024	C	FW-100 High Cast-in collar	UPVC - SC	110	4	100mm Chrome grate	P trap	-/241NF/ 204 (grate)
Proposed		FW-100 Low Cast-in collar	Geberit HDPE (PE 100, SDR 26)	110	5	150mm Brass grate	4 way - Floor waste gully	NA
FRT 210024	D	FW-100 Low Cast-in collar	Geberit HDPE (PE 100, SDR 26)	110	5	150mm Brass grate	P trap	-/241NF /240NF

Report	Pen. #	Collar Type	Pipe Material	Pipe OD (mm)	Pipe wall Thickness (mm)	Unexposed side	Config.	Integrity/ insulation (min.)
FSP 2199	2	FW-100 Low Cast-in collar	Dblue	110	3.4	Chrome plated brass grate	4 way - Floor waste gully	-/241NF /241NF
FSP 2199	3	FW-100 Low Cast-in collar	Rehua Raupiano Plus PP-MD	110	3.4	Chrome plated brass grate	4 way - Floor waste gully	-/241NF /241NF

With reference to the test data summarised in Table B6, it showed that

- The PVC floor waste pipe with a 4-way floor waste gully configuration allows the grate to maintain insulation for a longer period than when installed as a P trap configuration.
- The FW-100 High Cast-in collar was able to allow the floor waste grate to maintain insulation for a longer period than when protected with an FW-100 Low Cast-in collar.

Therefore, it is reasonable and conservative to expect the proposed PVC floor waste pipe with a 4-way floor waste gully configuration protected with FW-100 High Cast-in collar will be able to perform similarly or better than the tested PVC floor waste pipe with a P-trap configuration protected with FW-100 High Cast-in collar.

Therefore, it is reasonable and conservative to expect the proposed HDPE floor waste pipe with a 4-way floor waste gully configuration protected with FW-100 Low Cast-in collar will be able to perform similarly or better than the tested HDPE floor waste pipe with a P-trap configuration protected with FW-100 Low Cast-in collar.

The proposed increase in slab thickness to 175mm slab is thicker than the tested 150mm thick slab and thus would have more heat sink effect than the 150mm slab. It is therefore expected that the pipes installed in a 175mm thick slab will be able to maintain integrity for up to 240 minutes when protected with the proposed collars.

Confidence in the ability of the 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 for up to 180 and 240 minutes 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.

B.3 Variation to gap treatment

The proposed construction in Section 3.1 to Section 3.2 of this report may include the following variations in isolation or combination:

- The inclusion of variations listed in Sections B1 and B2
- Inclusion of Trafalgar Fyreflex sealant in place of tested sealant
- Gap treatment between cast-in collar and pipe as per Table 6

With reference to FSP 1358B specimen 2, the 20mm wide annular gap around a PVC pipe was sealed with Ramset Blazebrake acrylic sealant and was able to maintain integrity and insulation for up to 240 minutes.

With reference to FSP 2281 specimen 4, the 18mm wide annular gap around a PVC pipe was sealed with 10mm deep Trafalgar Fyreflex sealant and was able to maintain integrity and insulation for up to 240 minutes with no signs of integrity or insulation failure.

With reference to FRT 210025 specimen A, the 8.7mm wide annular gap around a metal pipe was sealed with 10mm deep Trafalgar Fyreflex sealant and was able to maintain integrity for up to 240 minutes with no signs of integrity failure.

With reference to test summary tables in Appendix A, the Trafalgar Fyreflex sealants have demonstrated that the sealant can maintain the seal and not cause flaming on a variety of materials for up to 240 minutes.

Based on the above, it is expected that the proposed 10mm or deeper application of Trafalgar Fyreflex sealant will allow gaps under 20mm wide gap around plastic stack pipes and paircoils to maintain integrity and insulation at the annular gap for up to 240 minutes if tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005.

Based on the above, it is expected that the proposed 10mm or deeper application of Trafalgar Fyreflex sealant will allow gaps under 10mm wide gap around metal pipes and paircoils to maintain integrity and insulation at the annular gap for up to 240 minutes if tested in accordance with AS 1530.4-2014 and assessed in accordance with AS 4072.1-2005.

B.4 Trimming of collar flange

By observation, the damaged or partially removed areas of the collars as shown in Figure 8 are limited to the plastic flange of the collar where no intumescent material is held.

The open nature of the exposed end of the collar 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 of the plastic pipe in the stages of the test. It is considered reasonable and conservative to consider this minor modification would not significantly affect the activation time of the intumescent material and in particular the spring in the collar.

B.5 Horizontal installation through a beam

The proposed variation comprises the Cast-In collars in Tables 2 - 5 to be installed horizontally in a beam as shown in Figure 10.

In theory, the performance of plastic pipes in walls is different than that in a floor application as the pipe can collapse at the opening to the collar before the collar has closed.

Provided that there is at least 100mm clearance around the Cast-In fire collar, the intumescent in the Cast-In fire collar will activate in a similar same manner and time as when installed in a slab.

Also, the proposed configuration would result in the plastic and metal pipes travelling through more sections of concrete which will as a heat sink to reduce the overall temperature of the pipe and the air temperature in the pipe compared to when installed in a straight manner in the slab.

The pipe being cast into the concrete will act to cool the pipe, delaying or even preventing the pipe from collapsing near the collar, prior to the collar closing.

Based on the above discussion, it is expected that the proposed construction will not detrimentally affect the integrity and insulation performance of the proposed collars 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.

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