



ASSESSMENT REPORT

The fire resistance performance of various plastic pipes penetrations in walls and floors protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 if tested in accordance with AS1530.4-2005 and assessed in accordance with AS4072.1-2005

EWFA Report No:

27006-03

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29/06/2015	27006-02	Revised to include insulated CPVC pipes
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1 INTRODUCTION

This report supersedes the previous edition EWFA 27006-02 and presents an assessment of the fire resistance performance of various plastic pipes penetrations in walls and floors protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 if tested in accordance with AS1530.4-2005 and assessed in accordance with AS4072.1-2005.

The tested prototypes described in Section 2 of this report, when subject to the proposed variations described in Section 3 and if tested in accordance with the referenced test method described in Section 4. The conclusions of the report are summarised in Section 5. The validity of this assessment is conditional on compliance with Sections 7, 8 and 9 of this report.

Summaries of the test data on which this assessment is based are provided in Appendix A together with a summary of the critical issues leading to the assessment conclusions including the main points of argument.

2 TESTED PROTOTYPES

This assessment is based on reference test reports EWFA 2626600.4 and EWFA 2626601.2.

Tests were sponsored by Hilti Australia Pty Ltd. and were undertaken by Exova Warringtonfire (Aus) Pty Ltd.

Reference is also made to test reports FSV 1025 and FSH 1028 were sponsored by Hilti Australia Pty Ltd and test reports 283513/3313FR, 285773/3333FR, 283512/3312FR and MPA 3209/3045 were sponsored by Hilti Entwicklungsgesellschaft mbH, who has granted permission for these test data to be referenced in this report. Refer to Appendix A for a full summary of the test data.

3 VARIATION TO TESTED PROTOTYPES

The proposed construction shall be PPR, PE-100, uPVC, RAUPIANO PLUS and insulated CPVC pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 as below.

3.1 PIPES, COLLARS AND FIXING METHODS

Table 1 –Uninsulated Pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Walls and Floors

Pipe Material	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)	Min. Aperture Diameter (mm)	Max. Aperture Diameter (mm)	Hilti Retrofit Firestop Collar CFS-C P/CP 644 Size	No. of Fixings
PPR	40	6	45	50	50/1.5"	2
	50	6.9	55	60	50/1.5"	2
	65	8.6	70	75	75/2.5"	3
	80	10.3	85	90	90/3"	3
	100	12.3	105	110	110/4"	4
	110	15	115	120	110/4"	4
	125	19	130	135	125/5"	4
PE-100 (HDPE)	40	5	45	50	50/1.5"	2
	50	4.6	55	60	50/1.5"	2
	65	5.8	70	75	75/2.5"	3
	80	6.8	85	90	90/3"	3
	100	8.2	105	110	110/4"	4
	110	12	115	120	110/4"	4
	125	13	130	135	125/5"	4
	200	20	205	210	200/8"	8

Pipe Material	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)	Min. Aperture Diameter (mm)	Max. Aperture Diameter (mm)	Hilti Retrofit Firestop Collar CFS-C P/CP 644 Size	No. of Fixings
UPVC*	43	2.0	48	53	50/1.5"	2
	56	2.2	61	66	63/2"	2
	69	2.7	74	79	75/2.5"	3
	85	2.9	90	95	90/3"	3
	110	3.2	115	120	110/4"	4
	160	4.5	165	170	160/6"	6
RAUPIANO PLUS	50	1.8	55	60	50/1.5"	2
	75	1.9	80	85	75/2.5"	3
	90	2.2	95	100	90/3"	3
	110	2.7	115	120	110/4"	4

*NOTE: uPVC pipes are not sandwich-core type.

Table 2 –Insulated Water Supply Pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Walls

Pipe Material	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)	Insulation Thickness (mm)	Total Outside Diameter (mm)	Min. Aperture Diameter (mm)	Max. Aperture Diameter (mm)	Hilti Retrofit Firestop Collar CFS-C P/CP 644 Size	No. of Fixings
CPVC	26.7	1.9-2.1	9	44.7	50	55	50/1.5"	2
	33.4	2.4-2.6	9	51.4	57	62	50/1.5"	2
	42.2	3.1-3.3	9	60.2	66	71	63/2"	2
	48.3	3.5-3.8	9	66.3	72	77	75/2.5"	3
	60.3*	4.4-4.7	13	86.3	92	97	75/2.5"	3

*Note: The application with a total outside diameter of 86.3mm is installed with the insulation slightly compressed, to fit inside the 75/2.5" version of the Hilti Retrofit Firestop Collar

Table 3 - Hilti Anchor Types for Hilti Retrofit Firestop Collar CFS-C P/CP 644 sizes smaller or equal to 90/3"

Anchoring Solution		Minimum Size	Flexible Walls (Plasterboard lined)	Solid Concrete Walls/Floors	
Screw anchors	HUS	M6		x	
Expansion anchors	HSA			x	
	HST			x	
	DBZ 6/45			x	
Internally threaded anchor	HKD			x	
Hollow core	HTB-S			x	
	HHD-S			x	
Other	Threaded steel rods with nuts and washer		x	x	
	Laminating/ Drywall/ Plasterboard Screws, at least 38mm in length, with steel washers of at least 19mm in diameter	10g	x		

Table 4 - Hilti Anchor Types for Hilti Retrofit Firestop Collar CFS-C P/CP 644 sizes larger than 90/3"

Anchoring Solution		Minimum Size	Flexible Walls (Plasterboard lined)	Solid Concrete Walls/Floors	
Screw anchors	HUS	M8		x	
Expansion anchors	HSA			x	
	HST			x	
	DBZ 6/45			x	
Internally threaded anchor	HKD			x	
Hollow core	HTB-S			x	
	HHD-S			x	
Other	Threaded rods with nuts and washer			x	x

3.2 SUPPORT CONSTRUCTION

The proposed Pipes collars and fixings above shall be installed in conjunction with the following;

- Concrete Floors shall be 120mm or thicker
- Plasterboard lined wall shall be steel or timber framed and lined with two layers of fire grade plasterboard linings on each side.
- Aperture size shall be as listed in Table 1 and 2

The proposed construction is detailed below:

Table 5 – Schedule of Components

Item	Description	
1	Name	PPR pipe
	Material	Polypropylene
	Size	Refer to Table 1
	Installation	Pipes to be supported at 500mm and 1500mm with metal pipe brackets from the wall.
2	Name	PE-100 (HDPE) pipe
	Material	High Density Polyethylene
	Size	Refer to Table 1
	Installation	Pipes to be supported at 500mm and 1500mm with metal pipe brackets from the wall.
3	Name	Hilti Retrofit Firestop Collar CFS-C P/CP 644
	Size	Refer to Table 1 and 2
	Installation	Fixed to each side of wall constructions and fixed to underside of floor construction.
4	Name	Annular Gap Seal and PE backing rod
	Specification	Hilti Firestop Acrylic Sealant CFS-S ACR/CP 606 and PE backing rod.

Item	Description	
	Installation	Fit PE backing rod to annular gap to limit depth of sealant. For wall, fill annular gap between pipe and wall on both side of the wall, at least 10mm deep. For concrete floor, fill annular gap between pipe and floor slab on the exposed side, at least 10mm deep.
5	Name	Fixing
	Specification	For collar sizes smaller or equal to 90/3", refer to Table 3 for fixing types. For collar sizes larger than 90/3", refer to Table 4 for fixing types.
6	Name	Support Construction – Wall
	Specification	Framed wall comprising of steel studs and timber clad with two layers of 13mm or 16mm thick fire resistance plasterboard each side.
7	Name	Support Construction - Floor
	Specification	Minimum 120mm thick normal weight reinforced concrete slab
8	Name	uPVC Pipe
	Material	uPVC*
	Size	Refer to Table 1
	Installation	Pipes to be supported at 500mm and 1500mm with metal pipe brackets from the wall on the unexposed side.
9	Name	RAUPIANO PLUS Pipe
	Material	Polypropylene
	Size	Refer to Table 1
	Installation	Pipes to be supported at 500mm and 1500mm with metal pipe brackets from the wall on the unexposed side
10	Name	CPVC Pipe
	Material	Chlorinated Polyvinyl Chloride
	Size	Refer to Table 2
	Installation	Pipes to be supported at 500mm and 1500mm
11	Name	Pipe Insulation
	Material	9mm or 13mm thick Armaflex AF, elastomeric combustible insulation material
	Installation	Wrapped along CPVC pipes (item 10) with a length of 250mm each side and continuous through the wall.
12	Name	Annular Gap Seal
	Material	Hilti Firestop Acrylic Sealant CFS-S ACR/CP 606
	Installation	For walls, filled annular gap between pipe and wall on both side of the wall, the full depth of wall lining.
13	Name	Annular Gap Seal
	Material	Gypsum plaster or mortar
	Installation	For concrete floors, filled annular gap between pipe and floor slab, the full depth of concrete slab.

*NOTE: uPVC pipes are not sandwich-Core type.

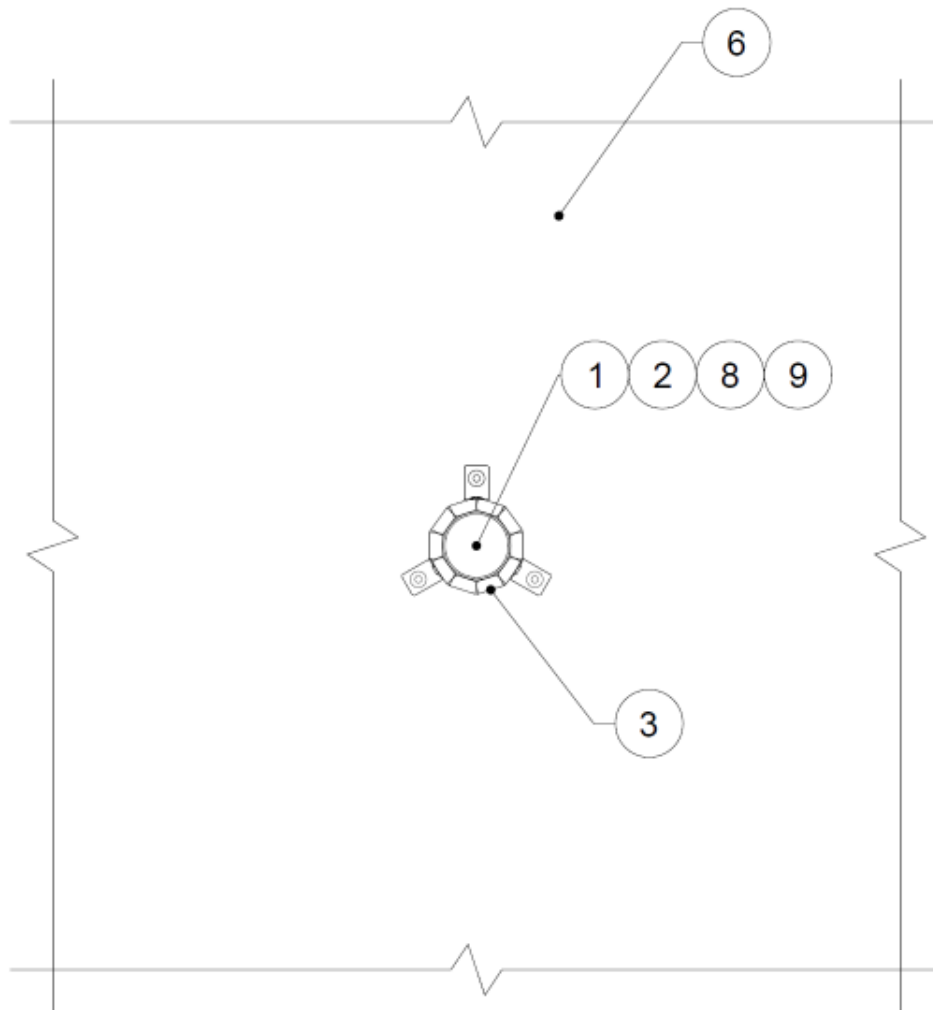


Figure 1 – Uninsulated Pipes with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Plaster board Walls
(Plaster board Wall Elevation)

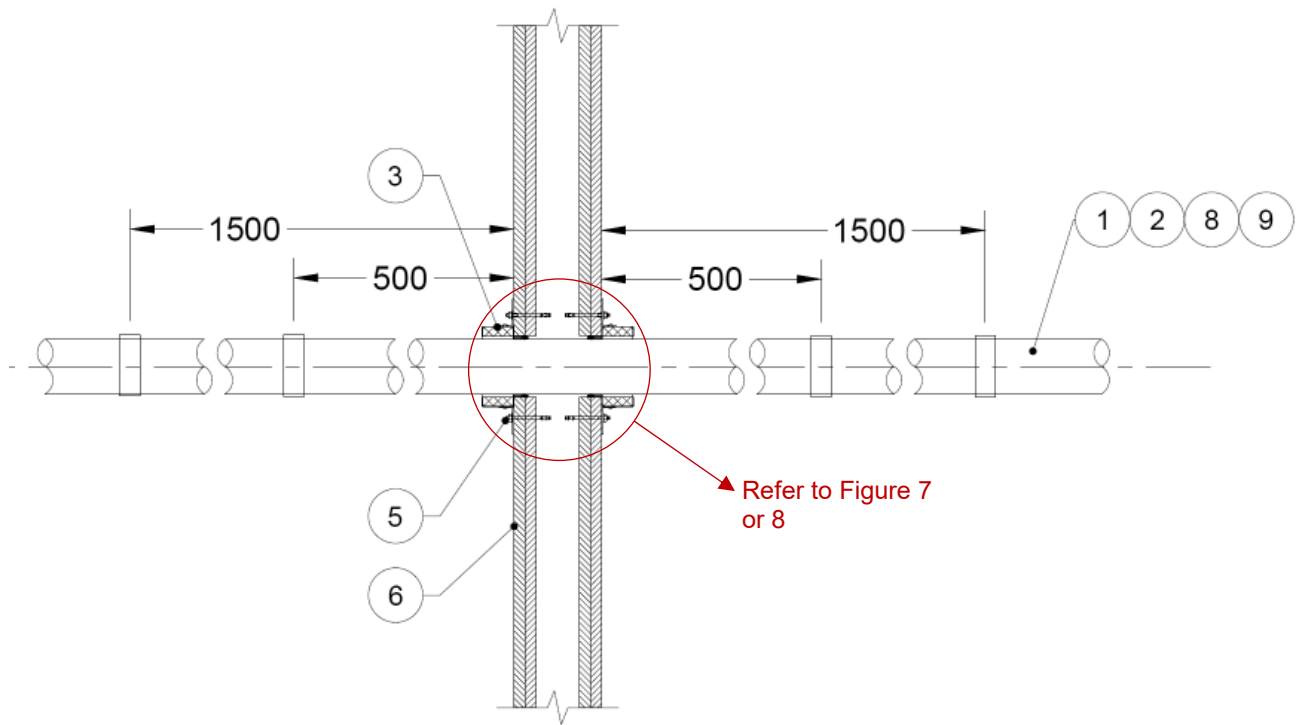


Figure 2 – Uninsulated Pipes with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Plaster board Walls
(Plaster board Wall Side View)

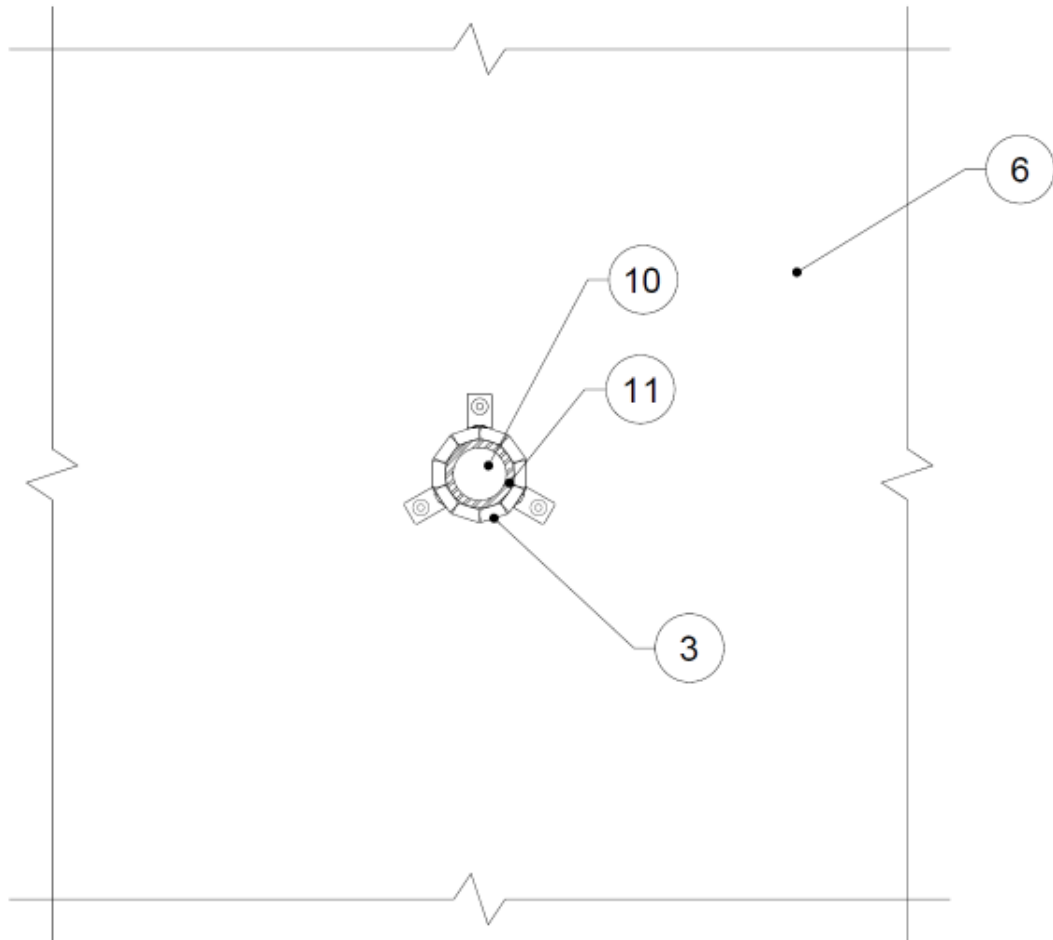


Figure 3 – Insulated Pipes with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Plaster board Walls
(Plaster board Wall Elevation)

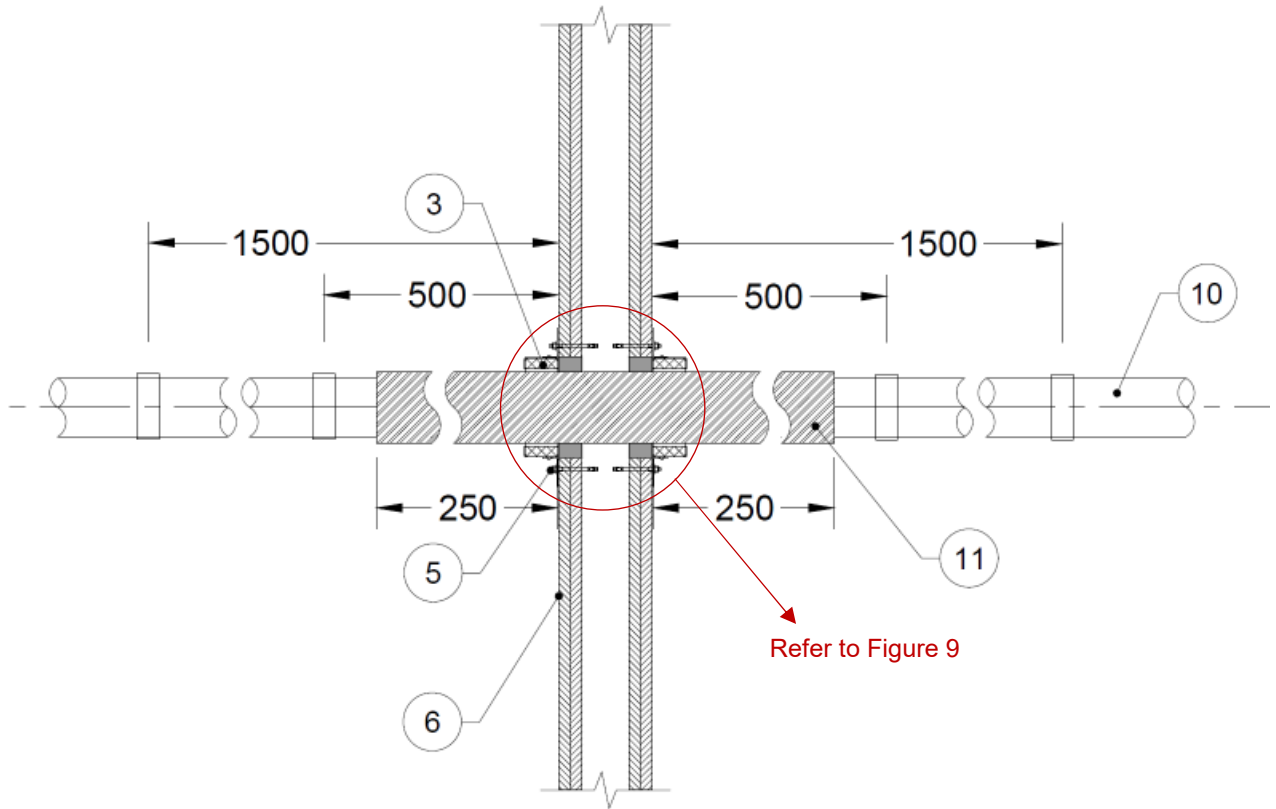


Figure 4 – Insulated Pipes with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Plaster board Walls
(Plaster board Wall Side View)

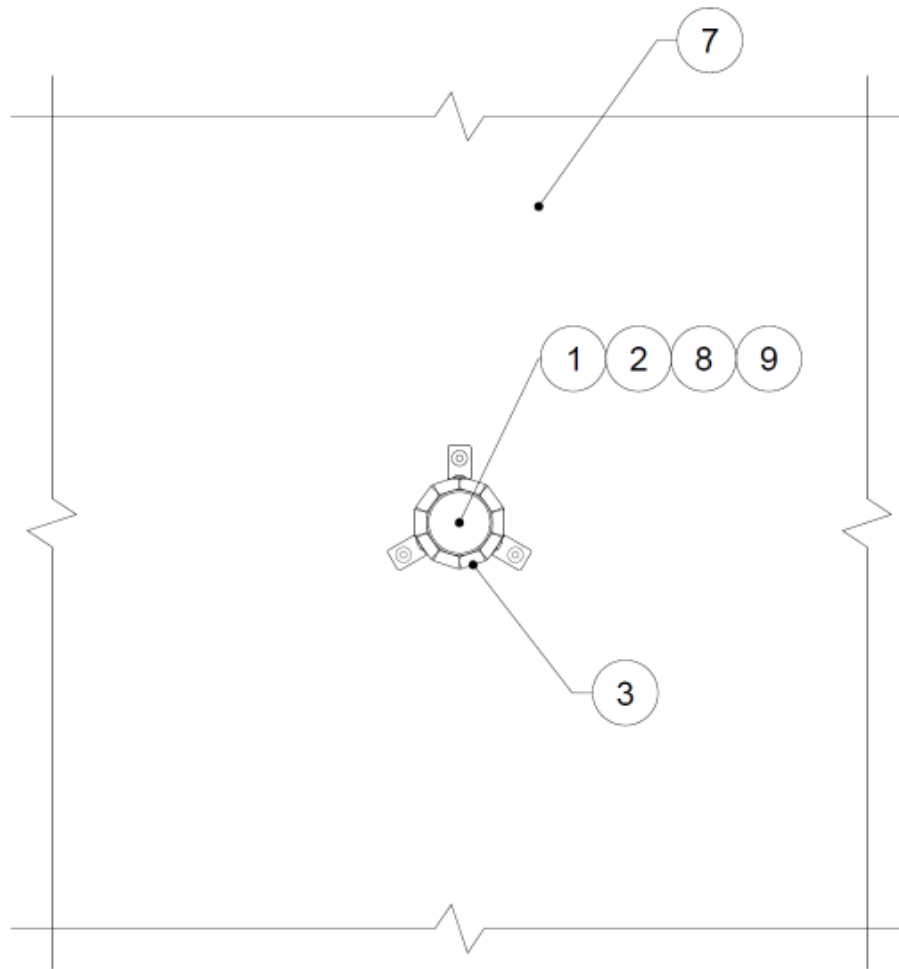


Figure 5 – Uninsulated Pipes with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Concrete Floors
(Concrete Floor Top View)

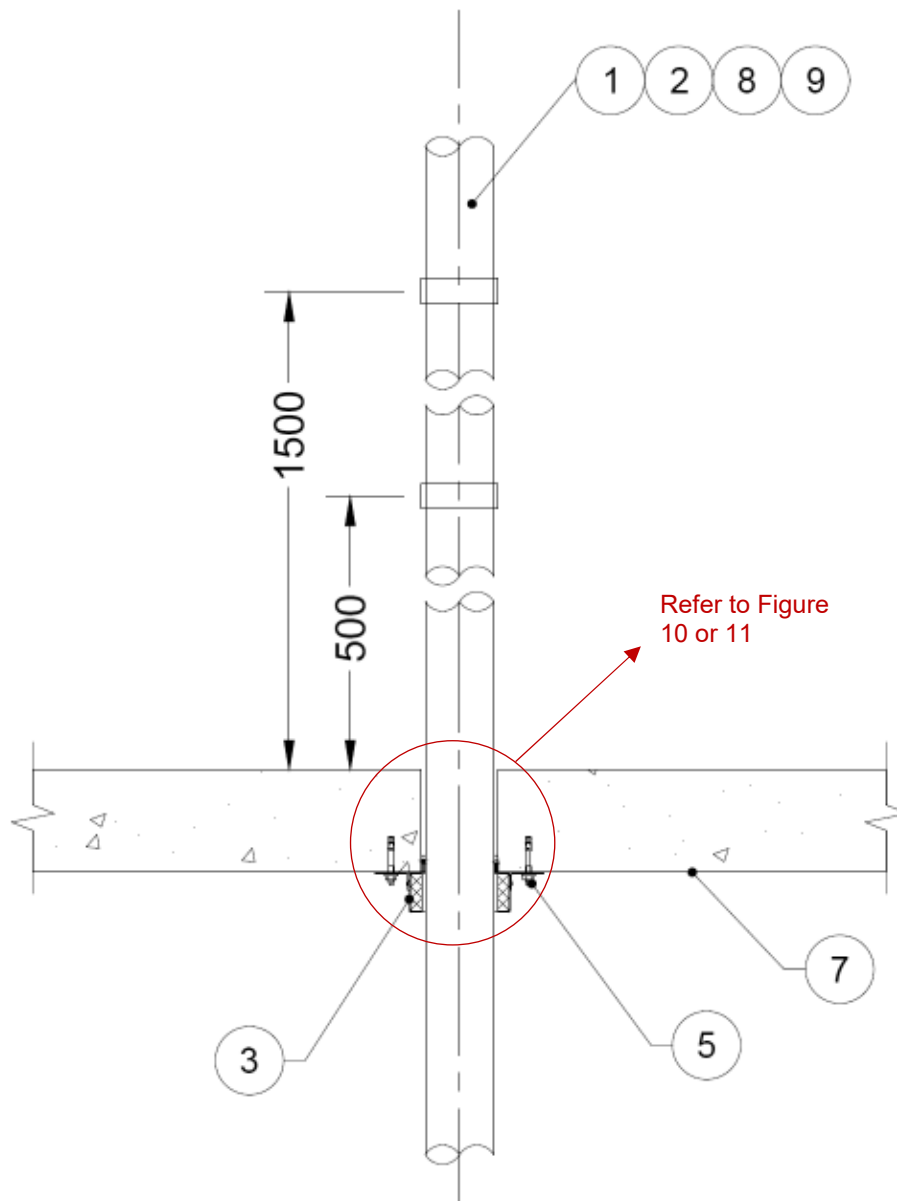


Figure 6 – Uninsulated Pipes with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in concrete Floors
(Concrete Floor Section View)

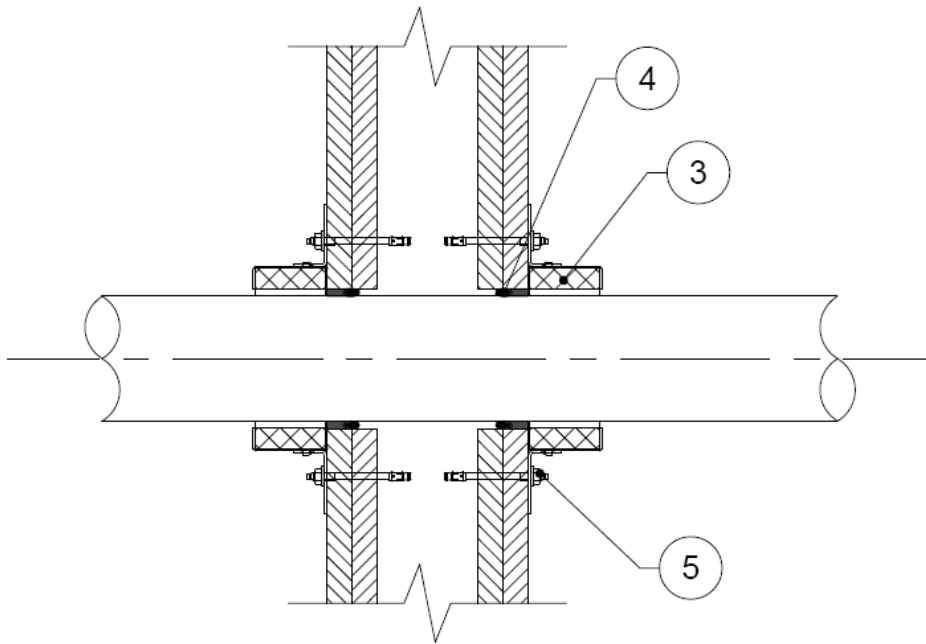


Figure 7 – Sealant Detail around Uninsulated Pipes in Plaster board Walls

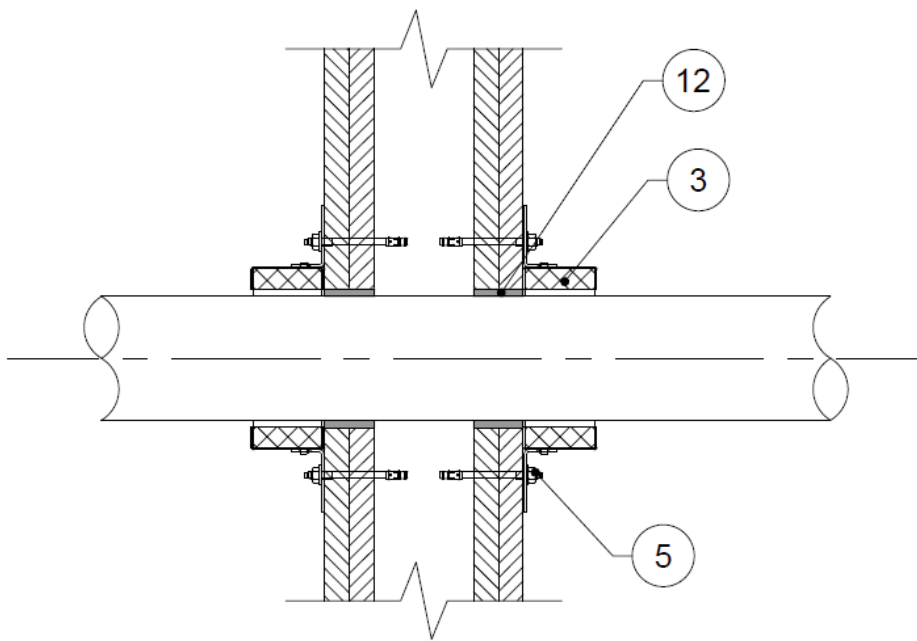


Figure 8 – Sealant Detail around Uninsulated Pipes in Plaster board Walls

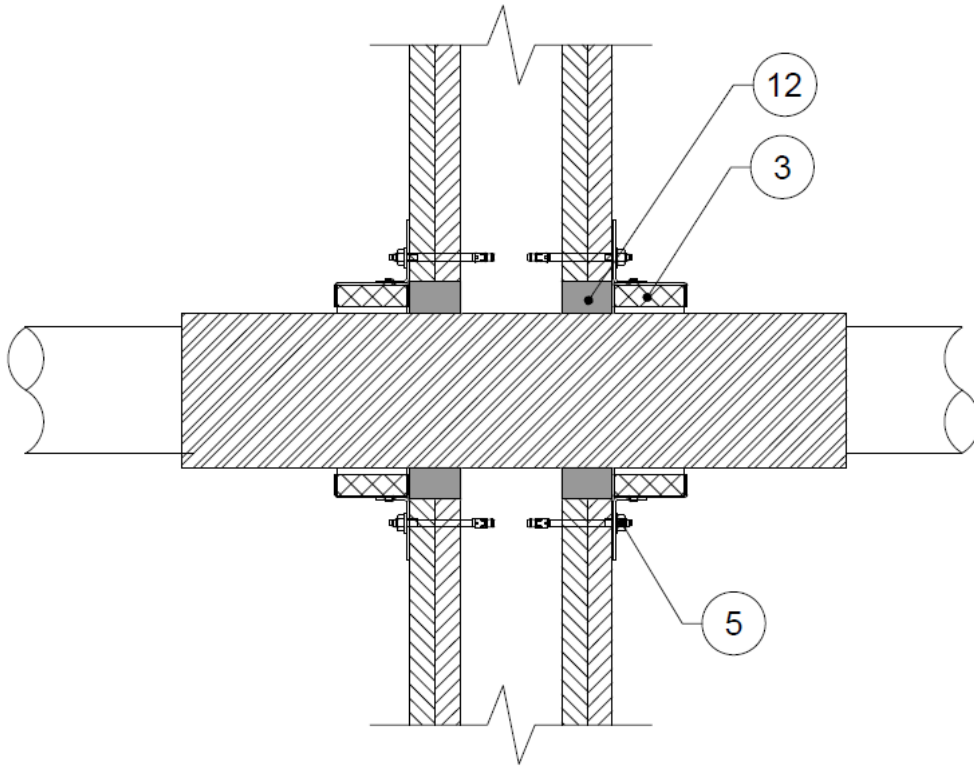


Figure 9 – Sealant Detail around Insulated Pipes in Plaster board Walls

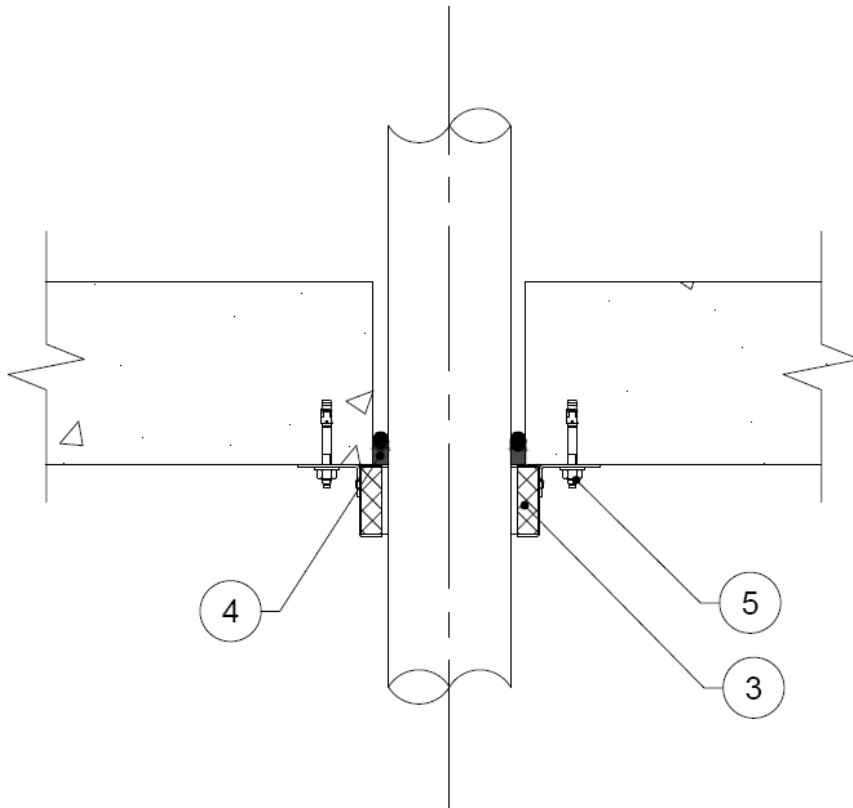


Figure 10 – Sealant Detail around Uninsulated Pipes in concrete Floors

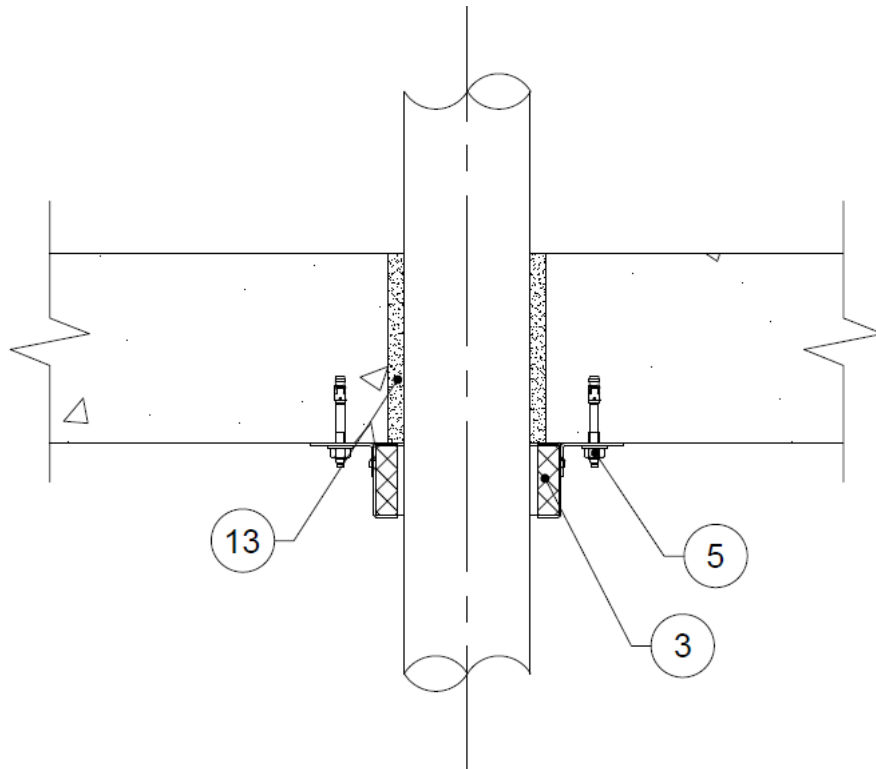


Figure 11 – Sealant Detail around Uninsulated Pipes in concrete Floors

4 REFERENCED TEST PROCEDURES

This report is prepared with reference to the requirements of AS1530.4-2014 Section 10 and AS4072.1-2005.

5 FORMAL ASSESSMENT SUMMARY

Based on the discussion presented in this report, it is the opinion of this testing authority that if the specimen described in section 2 had been modified within the scope of section 3, it will achieve the performance as stated below in if tested in accordance with the test method referenced in Section 4 and subject to the requirements of Section 7:

5.1 PIPES IN WALL CONSTRUCTION

Table 5.1 - uPVC Pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Plaster board walls

Pipe Material	Outside Diameter (mm)	Pipe Wall Thickness (mm)	Collar Size	Refer Figure	FRL 2X13mm thick Walls	FRL 2X16mm thick Walls
uPVC	43	2.0	50/1.5"	Figures 1 & 2, 7 or 8	-/120/90	-/120/90
	56	2.2	63/2"		-/120/120	-/120/120
	69	2.7	75/2.5"		-/120/90	-/120/90
	85	2.9	90/3"		-/120/90	-/120/90
	110	3.2	110/4"		-/120/120	-/120/120
	160	4.5	160/6"		-/120/120	-/120/120

*Note: FRL applies to normal uPVC pipes and not sandwich-core uPVC pipes

Table 5.2 - PPR Pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Plaster board walls

Pipe Material	Outside Diameter (mm)	Pipe Wall Thickness (mm)	Collar Size	Refer Figure	FRL 2X13mm thick Walls	FRL 2X16mm thick Walls
PPR	40	6	50/1.5"	Figures 1 & 2, 7 or 8	-/120/120	-/120/120
	50	6.9	50/1.5"		-/120/120	-/120/120
	65	8.6	75/2.5"		-/120/90	-/120/90
	80	10.3	90/3"		-/120/90	-/120/90
	100	12.3	110/4"		-/120/120	-/120/120
	110	15	110/4"		-/120/120	-/120/120
	125	19	125/5"		-/120/120	-/120/120

Table 5.3 - PE-100 Pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Plaster board walls

Pipe Material	Outside Diameter (mm)	Pipe Wall Thickness (mm)	Collar Size	Refer Figure	FRL 2X13mm thick Walls	FRL 2X16mm thick Walls
PE-100 (HDPE)	40	5	50/1.5"	Figures 1 & 2, 7 or 8	-/120/120	-/120/120
	50	4.6	50/1.5"		-/120/120	-/120/120
	65	5.8	75/2.5"		-/120/90	-/120/90
	80	6.8	90/3"		-/120/90	-/120/90
	100	8.2	110/4"		-/120/120	-/120/120
	110	12	110/4"		-/120/120	-/120/120
	125	13	125/5"		-/120/120	-/120/120
	200	20	200/8"		-/120/60	-/120/60

Table 5.4 - REHAU RAUPIANO PLUS Pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Plaster board walls

Pipe Material	Outside Diameter (mm)	Pipe Wall Thickness (mm)	Collar Size	Refer Figure	FRL 2x13mm (116mm Walls)
RAUPIANO PLUS	50	1.8	50/1.5"	Figures 1 & 2, 8	-/120/120
	75	1.9	75/2.5"		-/120/120
	90	2.2	90/3"		-/120/120
	110	2.7	110/4"		-/120/120

Table 5.5 - Water Supply CPVC Pipes insulated with Armaflex AF and protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in Plaster board walls

Pipe Material	Outside Diameter (mm)	Pipe Wall Thickness (mm)	Insulation Thickness (mm)	Collar Size	Refer Figure	FRL 100mm Walls
CPVC	26.7	1.9-2.1	9	50/1.5"	Figures 3, 4 & 9	-/120/120
	33.4	2.4-2.6	9	50/1.5"		-/120/120
	42.2	3.1-3.3	9	63/2"		-/120/120
	48.3	3.5-3.8	9	75/2.5"		-/120/120
	60.3*	4.4-4.7	13	75/2.5"		-/120/120

*Note: The application with a total outside diameter of 86.3mm is installed with the insulation slightly compressed, to fit inside the 75/2.5" version of the Hilti Retrofit Firestop Collar

5.2 PIPES IN FLOOR CONSTRUCTION

Table 5.6 - uPVC Pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in concrete floors

Pipe Material	Outside Diameter (mm)	Pipe Wall Thickness (mm)	Collar Size	Refer Figure	FRL >120mm slab
uPVC	43	2.0	50/1.5"	Figures 5 & 6, 10 or 11	-/240/240
	56	2.2	63/2"		-/240/240
	69	2.7	75/2.5"		-/240/240
	85	2.9	90/3"		-/240/240
	110	3.2	110/4"		-/240/240
	160	4.5	160/6"		-/240/240

*Note: FRL applies to normal uPVC pipes and not sandwich-core uPVC pipes

Table 5.7 - PPR Pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in concrete floors

Pipe Material	Outside Diameter (mm)	Pipe Wall Thickness (mm)	Collar Size	Refer Figure	FRL >120mm slab
PPR	40	6	50/1.5"	Figures 5 & 6, 10 or 11	-/180/120
	50	6.9	50/1.5"		-/120/120
	65	8.6	75/2.5"		-/120/120
	80	10.3	90/3"		-/120/120
	100	12.3	110/4"		-/120/120
	110	15	110/4"		-/120/120
	125	19	125/5"		-/240/120

Table 5.8 - PE-100 Pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in concrete floors

Pipe Material	Outside Diameter (mm)	Pipe Wall Thickness (mm)	Collar Size	Refer Figure	FRL >120mm Slab
PE-100 (HDPE)	40	5	50/1.5"	Figures 5 & 6, 10 or 11	-/180/120
	50	4.6	50/1.5"		-/90/90
	65	5.8	75/2.5"		-/90/90
	80	6.8	90/3"		-/90/90
	100	8.2	110/4"		-/90/90
	110	12	110/4"		-/90/90
	125	13	125/5"		-/60/60
	200	20	200/8"		-/30/30

Table 5.9 - REHAU RAUPIANO PLUS Pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in concrete floors

Pipe Material	Outside Diameter (mm)	Pipe Wall Thickness (mm)	Collar Size	Refer Figure	FRL >120mm slab
RAUPIANO PLUS	50	1.8	50/1.5"	Figures 5 & 6, 11	-/120/120
	75	1.9	75/2.5"		-/120/120

Pipe Material	Outside Diameter (mm)	Pipe Wall Thickness (mm)	Collar Size	Refer Figure	FRL >120mm slab
	90	2.2	90/3"		-/120/120
	110	2.7	110/4"		-/120/120

6 DIRECT FIELD OF APPLICATION

This assessment applies to penetrations in walls exposed to fire from either side and to floors exposed to fire from below.

7 REQUIREMENTS

This report details the methods of construction, test conditions and assessed results that would have been expected had the specific elements of construction described herein been tested in accordance with AS 1530.4-2014.

It is required that the walls and floor be made construction having an FRL at least that required of the penetration

Any further variations with respect to size, constructional details, loads, stresses, edge or end conditions, other than those identified in this report, may invalidate the conclusions drawn in this report.

8 VALIDITY

This assessment report does not provide an endorsement by Exova Warringtonfire Aus Pty Ltd of the actual products supplied.

The conclusions of this assessment 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.

The assessment can therefore only relate only to the actual prototype test specimens, testing conditions and methodology described in the supporting data, and does not imply any performance abilities of constructions 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 be reviewed on or, before, the stated expiry date.

The information contained in this 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.

9 AUTHORITY

9.1 APPLICANT UNDERTAKINGS AND CONDITIONS OF USE

By using this report as evidence of compliance or performance, the applicant(s) confirms that: to their knowledge the component or element of structure, which is the subject of this assessment, has not been subjected to a fire test to the Standard against which this assessment is being made, and

they agree to withdraw this assessment from circulation should the component or element of structure be the subject of a fire test by a test authority in accordance with the Standard against which this assessment is being made and the results are not in agreement with this assessment, and

they are not aware of any information that could adversely affect the conclusions of this assessment and if they subsequently become aware of any such information, agree to ask the assessing authority to withdraw the assessment.

9.2 GENERAL CONDITIONS OF USE

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9.3 AUTHORISATION ON BEHALF OF EXOVA WARRINGTONFIRE AUS PTY LTD

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9.4 DATE OF ISSUE

29/03/2018

9.5 EXPIRY DATE

29/03/2023

APPENDIX A - SUMMARY OF SUPPORTING DATA

A.1 TEST REPORT - EWFA 2626600.4

A.1.1 Report Sponsor

A.1.1.1 Hilti Australia Pty Ltd, 1G Homebush Bay Drive, Rhodes, NSW 2138

A.1.2 Test Laboratory

A.1.2.1 Exova Warringtonfire Aus Pty Ltd, Unit 2, 409-411 Hammond Rd, Dandenong, Vic 3175.

A.1.3 Test Date

A.1.3.1 The fire resistance test was conducted on 21st October 2011.

A.1.4 Test Standard

A.1.4.1 The test was conducted in accordance with AS1530.4-2005.

A.1.5 Variations to Test Method

A.1.5.1 The furnace pressure exceeded the limits stated in AS 1530.4-2005 for various periods during the test by -6Pa up to +8Pa from the specified 15±3Pa limit specified in the standard.

A.1.5.2 This variation in pressure is unlikely to have significantly affected the result of the test as the average pressure for the duration of the test were within the limits specified by the standard.

A.1.6 General Description of Tested Specimen

A.1.6.1 The test assembly comprised a nominal 1200mm wide × 1200mm high × 128mm thick steel framed plasterboard wall penetrated by various diameter Vinidex PE-100 and Aquatherm PPR plastic pipes. Only Service Penetrations A to G are relevant to this assessment.

A.1.6.2 These penetrations were protected by Hilti CP 644 fire collars. The specimens are described below:

ID	Description	Protection	Annular Gap Size	Annular Gap Protection
A	Ø40mm (OD) × 6.0mm thick Aquatherm PPR fibre reinforced pipe	Hilti CP 644 Collar fixed to both sides of the wall.	5mm	10mm deep CP 606 sealant backed with 10mm backing rod each side
B	Ø125mm (OD) × 19mm thick Aquatherm PPR fibre reinforced pipe	Hilti CP 644 Collar fixed to both sides of the wall.	12.5mm	10mm deep CP 606 sealant backed with 10mm backing rod each side
C	Ø110mm (OD) × 15mm thick Aquatherm PPR fibre reinforced pipe	Hilti CP 644 Collar fixed to both sides of the wall.	7.5mm	10mm deep CP 606 sealant backed with 10mm backing rod each side
D	Ø40mm (OD) × 5.0mm thick Vinidex PE-100 pipe	Hilti CP 644 Collar fixed to both sides of the wall.	5mm	10mm deep CP 606 sealant backed with 10mm backing rod each side
E	Ø110mm (OD) × 12mm thick Vinidex PE-100 pipe	Hilti CP 644 Collar fixed to both sides of the wall.	12.5mm	10mm deep CP 606 sealant backed with 10mm backing rod each side
F	Ø125mm (OD) × 13mm thick Vinidex PE-100 pipe	Hilti CP 644 Collar fixed to both sides of the wall.	12.5mm	10mm deep CP 606 sealant backed with 10mm backing rod each side

ID	Description	Protection	Annular Gap Size	Annular Gap Protection
G	Ø200mm (OD) × 20mm thick Vinidex PE-100 pipe	Hilti CP 644 Collar fixed to both sides of the wall.	25mm	20mm deep CP606 sealant backed with 10mm backing rod each side

A.1.6.3 The plastic pipes were supported at 500mm and 1500mm on the unexposed side from the unexposed face of support construction.

A.1.6.4 The plastic pipes above extended 530mm and 2000mm on the exposed and unexposed sides respectively, and was capped on the exposed side.

A.1.7 Instrumentation

A.1.7.1 The instrumentation was provided and applied in accordance with AS 1530.4- 2005.

A.1.8 Test Results

A.1.8.1 The test duration was 195 minutes.

A.1.8.2 The specimens achieved the following performance when evaluated against the failure criteria of AS 1530.4- 2005:

ID	Integrity	Insulation
A	No failure at 195 minutes	Failure at 163 minutes; 180°C rise in temperature for thermocouple on collar, 25mm from the wall
B	No failure at 195 minutes	Failure at 188 minutes; 180°C rise in temperature for thermocouple on wall, 25mm from the pipe
C	No failure at 195 minutes	Failure at 162 minutes; 180°C rise in temperature for thermocouple on collar, 25mm from the wall
D	No failure at 195 minutes	Failure at 159 minutes; 180°C rise in temperature for thermocouple on collar, 25mm from the wall
E	Failure at 182 minutes; Glowing of the cotton pad had become evident at the interface of the wall and collar	Failure at 147 minutes; 180°C rise in temperature for thermocouple on wall, 25mm from the pipe
F	No failure at 195 minutes	No failure at 195 minutes
G	Failure at 187 minutes; Glowing of the cotton pad had become evident at the interface of the wall and collar	Failure at 83 minutes; 180°C rise in temperature for thermocouple on collar, 25mm from the wall

A.2 TEST REPORT - EWFA 2626601.2

A.2.1 Report Sponsor

A.2.1.1 Hilti Australia Pty Ltd, 1G Homebush Bay Drive, Rhodes, NSW 2138

A.2.2 Test Laboratory

A.2.2.1 Exova Warringtonfire Aus Pty Ltd, Unit 2, 409-411 Hammond Rd, Dandenong, Vic 3175.

A.2.3 Test Date

A.2.3.1 The fire resistance test was conducted on 21st October 2011.

A.2.4 Test Standard

A.2.4.1 The test was conducted in accordance with AS1530.4-2005 and AS4072.1-2005.

A.2.5 Variations to Test Method

- A.2.5.1 The furnace pressure exceeded the limits stated in AS 1530.4-2005 at various periods during the test by up to -21Pa between 25 minutes and 45 minutes to the partial degradation and venting in conjunction with the collar on specimen G. for the remainder of the test the average pressure was within the limits specified by the standard.
- A.2.5.2 The variation in pressure is likely to have significantly affected the result of the test for specimen G up to 45 minutes and as such the results for this service are likely to be lower than if subjected to a pressure condition in strict accordance with the standard.
- A.2.5.3 Between 20 and 45 minutes it was evident that all other collars had closed and that no gaps were present in conjunction with collars on service A-E.
- A.2.5.4 The variation in pressure is unlikely to have significantly affected the result of the test for specimens A-E between 20 and 45 minutes as there were no gaps present would allow the transit of hot gases at this time.

A.2.6 General Description of Tested Specimen

- A.2.6.1 The test assembly comprised a nominal 1750mm long × 1200mm wide × 120mm thick normal weight reinforced concrete slab penetrated by various diameter Vinidex PE-100 and Aquatherm PPR plastic pipes
- A.2.6.2 Only service penetrations A to G are relevant to this assessment. These penetrations were protected by Hilti CP 644 fire collars. The specimens are described below:

ID	Description	Protection	Annular Gap Size	Annular Gap Protection
A	Ø40mm (OD) × 6.0 thick Aquatherm PPR pipe	Hilti CP 644 Collar fixed to underside of slab.	5mm	10mm deep CP 606 sealant backed with 10mm backing rod on the expose side only
B	Ø125mm (OD) × 19mm thick Aquatherm PPR pipe	Hilti CP 644 Collar fixed to underside of slab.	12.5mm	10mm deep CP 606 sealant backed with 10mm backing rod on the expose side only
C	Ø110mm (OD) × 15mm thick Aquatherm PPR pipe	Hilti CP 644 Collar fixed to underside of slab.	7.5mm	10mm deep CP 606 sealant backed with 10mm backing rod on the expose side only
D	Ø40mm (OD) × 5mm thick Vinidex PE-100 pipe	Hilti CP 644 Collar fixed to underside of slab.	5mm	10mm deep CP 606 sealant backed with 10mm backing rod on the expose side only
E	Ø110mm (OD) × 12mm thick Vinidex PE-100 pipe	Hilti CP 644 Collar fixed to underside of slab.	12.5mm	10mm deep CP 606 sealant backed with 10mm backing rod on the expose side only
F	Ø125mm (OD) × 13mm thick Vinidex PE-100 pipe	Hilti CP 644 Collar fixed to underside of slab.	12.5mm	10mm deep CP 606 sealant backed with 10mm backing rod on the expose side only
G	Ø200mm (OD) × 20mm thick Vinidex PE-100 pipe	Hilti CP 644 Collar 125 fixed to underside of slab.	25mm	10mm deep CP 606 sealant backed with 10mm backing rod on the expose side only

A.2.6.3 The plastic pipes were supported at 500mm and 1500mm on the unexposed side from the unexposed face of support construction.

A.2.6.4 The plastic pipes above extended 530mm and 2000mm on the exposed and unexposed sides respectively, and was capped on the exposed side.

A.2.7 Instrumentation

A.2.7.1 The instrumentation was provided and applied in accordance with AS 1530.4- 2005.

A.2.8 Test Results

A.2.8.1 The test duration was 241 minutes.

A.2.8.2 The specimens achieved the following performance when evaluated against the failure criteria of AS 1530.4- 2005:

Service	Integrity	Insulation
A	Failure at 216 minutes; Sustained flaming of pipe for more than 10 seconds	Failure at 177 minutes; 180°C rise in temperature for thermocouple on slab, 25mm from the pipe
B	No failure at 241 minutes	Failure at 173 minutes; 180°C rise in temperature for thermocouple on slab, 25mm from the pipe
C	Failure at 176 minutes; Glowing of cotton pad had become evident at the interface of the wall and collar	Failure at 176 minutes; Service failure
D	Failure at 210 minutes; Flaming at the pipe/slab interface for greater than 10 seconds	Failure at 165 minutes; 180°C rise in temperature for thermocouple on slab, 25mm from the pipe
E	Failure at 107 minutes; Glowing of cotton pad had become evidence at the interface of pipe and slab	Failure at 107 minutes; Service failure
F	Failure at 81 minutes; Glowing of cotton pad had become evidence at the interface of pipe and slab	Failure at 81 minutes; Service failure
G	Failure at 43 minutes; Deformation had become evident on the pipe inside the slab, glowing of the cotton pad had become evident at the interface of the pipe and slab.	Failure at 43 minutes; Service failure

A.3 TEST REPORT – FSV 1025

A.3.1 Test Sponsor

A.3.1.1 Hilti Australia Pty Ltd, 23 Egerton Street, Silverwater NSW, Australia.

A.3.2 Test Laboratory

A.3.2.1 Warrington Fire Research (Aust) Pty Ltd, Unit 2, 409-411 Hammond Rd, Dandenong, Vic 3175.

A.3.3 Date of Test

A.3.3.1 The fire resistant test was conducted on 18th December 2003.

A.3.4 Summary of test:

A.3.4.1 The specimen tested in accordance with AS 1530.4-1997 comprised a 3000mm high × 3000mm wide × 115mm thick framed wall system with two layers of 13mm fire grade plasterboard on each face of a 64mm steel or timber stud frame.

A.3.4.2 The wall was penetrated by eighteen pipe penetrations consisting of retro-fit Firestop jackets and Firestop wraps. Three retro-fit Firestop jackets were also installed on the fire exposed face with alternative methods of fixing.

A.3.4.3 All the pipes penetrated into the furnace by at least 100mm and extended out from the unexposed face by at least 2000mm. The pipes were supported by a steel frame assembly with pipe clamps at nominally 500mm and 1500mm from the wall. All pipes were capped on the exposed face

A.3.4.4 At the request of the sponsor, only Penetrations 1 to 6 from this test report are considered in the assessment. Their assemblies are summarized below:

ID	Pipe Material	Outside Pipe Diameter (OD) mm	Wall Thickness (mm)	Collar Type	Annular Gap Size	Annular Gap Protection
1	uPVC	43	2.0	CP 643	6mm	10mm deep CP 606 sealant on each side if gap formed
2	uPVC	56	2.2	CP 643	4.5mm	
3	uPVC	69	2.7	CP 643	5.5mm	
4	uPVC	85	2.9	CP 643	5mm	
5	uPVC	111	3.2	CP 643	0mm	
6	uPVC	160	4.5	CP 643	7.5mm	

A.3.4.5 The test was terminated after a period of 122 minutes.

A.3.4.6 The fire resistance performance of the penetrations was monitored for the duration of the test and it satisfied the performance criteria in accordance with AS1530.4-1997 for the following periods:

ID	Structural Adequacy	Integrity (min)	Insulation (min)
1	Not Applicable	No failure at 120 minutes	Failure at 114 minutes; Maximum temperature exceeded on the collar
2	Not Applicable	No failure at 120 minutes	No failure at 120 minutes
3	Not Applicable	No failure at 120 minutes	Failure at 115 minutes; Maximum temperature exceeded on the collar
4	Not Applicable	No failure at 120 minutes	Failure at 108 minutes; Maximum temperature exceeded on the pipe, 25mm from the wall
5	Not Applicable	No failure at 120 minutes	No failure at 120 minutes

ID	Structural Adequacy	Integrity (min)	Insulation (min)
6	Not Applicable	No failure at 120 minutes	No failure at 120 minutes

A.4 TEST REPORT – FSH 1028

A.4.1 Test Sponsor

A.4.1.1 Hilti Australia Pty Ltd, 23 Egerton Street, Silverwater NSW, Australia.

A.4.2 Test Laboratory

A.4.2.1 Warrington Fire Research (Aus) Pty Ltd, Unit 2, 409-411 Hammond Rd, Dandenong, Vic 3175.

A.4.3 Date of Test

A.4.3.1 The fire resistant test was conducted on 10th January 2004.

A.4.4 Summary of test:

A.4.4.1 The specimen tested in accordance with AS 1530.4-1997 comprised two nominal 150mm thick concrete slabs positioned on top of a horizontal furnace with a blocking off piece in the middle of the furnace between the two slabs.

A.4.4.2 The slabs were penetrated by twenty two pipe penetrations consisting of Firestop jackets, Cast-in Firestop collars and Firestop wraps and four electrical cable penetrations. Five Firestop jackets were also installed on the fire exposed face with alternative methods of fixing.

A.4.4.3 All the pipes penetrated into the furnace by at least 100mm and extended out from the unexposed face by at least 2000mm. The pipes were supported by a steel frame assembly with pipe clamps at nominally 500mm and 1500mm from the wall. All pipes were capped on the exposed face. The conduits and cables were supported at nominally 500mm from the slab.

A.4.4.4 At the request of the sponsor, only Penetrations 1 to 6 from this test report are considered in the assessment. Their assemblies are summarized below:

ID	Pipe Material	Outside Pipe Diameter (OD) mm	Wall Thickness (mm)	Collar Type	Annular Gap Size (mm)	Annular Gap Protection
1	uPVC	43	2.0	CP 643	10	Mortar filled the full depth of concrete slab if gap formed
2	uPVC	56	2.2	CP 643	9.5	
3	uPVC	69	2.7	CP 643	10	
4	uPVC	85	2.9	CP 643	7.5	
5	uPVC	111	3.2	CP 643	7	
6	uPVC	160	4.5	CP 643	7.5	

A.4.4.5 The test was terminated after a period of 241 minutes.

A.4.4.6 The fire resistance performance of the penetrations was monitored for the duration of the test and it satisfied the performance criteria in accordance with AS1530.4-1997 for the following periods:

ID	Structural Adequacy	Integrity (min)	Insulation (min)
1	Not Applicable	No failure at 240 minutes	No failure at 240 minutes
2	Not Applicable	No failure at 240 minutes	No failure at 240 minutes
3	Not Applicable	No failure at 240 minutes	No failure at 240 minutes
4	Not Applicable	No failure at 240 minutes	No failure at 240 minutes
5	Not Applicable	No failure at 240 minutes	No failure at 240 minutes
6	Not Applicable	No failure at 240 minutes	No failure at 240 minutes

A.5 RELEVANCE OF AS1530.4- 1997 TEST DATA WITH RESPECT TO AS1530.4- 2005

A.5.1 General

A.5.1.1 The referenced fire resistance tests FSV 1025 and FSH 1028 were conducted in accordance with AS 1530.4–1997, which differs slightly from AS 1530.4–2005. These variations and their potential effect on the fire resistance performance of the referenced test specimen are discussed below.

Temperature Regime

A.5.1.2 The furnace heating regime in fire resistance tests conducted in accordance with AS 1530.4–2005 follows a similar trend to that in AS 1530.4–1997. The specified specimen heating rate in AS 1530.4–1997 is given by:

$$T_t - T_0 = 345 \log(8t + 1)$$

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

T_0 = 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.

A.5.1.3 The heating regimes in AS 1530.4–1997 and AS 1530.4–2005 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 1530.4–2005.

A.5.1.4 The parameters outlining the accuracy of control of the furnace temperature in AS 1530.4–2005 and AS 1530.4–1997 are not appreciably different.

Furnace Pressure

A.5.1.5 The furnace pressure level and control parameters in AS 1530.4–2005 and AS 1530.4–1997 are not appreciably different.

Furnace Thermocouples

A.5.1.6 The furnace thermocouples specified in both AS1530.4-2005 and AS1530.4-1997 are type K, mineral insulated metal sheathed (MIMS) with a stainless steel sheath having a wire of diameter of less than 1.0mm and an overall diameter of 3mm. The measuring junction protrudes at least 25mm from the supporting heat resistant tube.

A.5.1.7 The relative location of the furnace thermocouples to the exposed face of the specimen, for both AS1530.4-2005 and AS1530.4-1997, is 100mm +10mm.

Specimen Thermocouples

A.5.1.8 The prescribed specimen thermocouple locations are not appreciably different between AS1530.4- 1997 and AS1530.4- 2005.

Performance Criteria

A.5.1.9 AS 1530.4–2005 specifies the following performance criteria for building materials and structures:

- Structural Adequacy
- Integrity
- Insulation

Structural Adequacy

A.5.1.10 The structural adequacy criteria are not relevant to this test.

Integrity

A.5.1.11 The specimen shall be deemed to have failed the integrity criterion in accordance with AS 1530.4–2005 (in regard to service penetrations) if the specimen

- Collapses
- Sustains flaming on the non-fire side in excess of 10 seconds
- Ignites a cotton pad within 30 seconds when applied.

A.5.1.12 The specimen is deemed to have failed to AS 1530.4- 1997 if the specimen

- Collapses
- Develops cracks, fissures or, other openings through which flames or hot gases can pass
- Sustains flaming on the non-fire side

A.5.1.13 The integrity requirements for AS1530.4-2005 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.

A.5.1.14 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 tests FSV 1025 and FSH 1028.

A.5.1.15 As those specimens which failed the integrity criterion were due to sustained flaming or the formation of a through gap with an uninterrupted view, the slight variations in integrity criterion would not be expected to significantly affect the integrity performance of the service penetrations in the referenced tests if tested in accordance with AS1530.4- 2005.

Insulation

A.5.1.16 The insulation criteria of AS 1530.4–1997 and AS 1530.4–2005 are not appreciably different.

Specimen Size, Support and End Conditions

A.5.1.17 The AS1530.4- 2005 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 AS1530.4- 1997 standard has the same minimum 2000mm extension requirement away from the furnace, but prescribes only 100mm minimum extension into the furnace. It is confirmed that some of the referenced test specimens did not meet the AS1530.4- 2005 requirement for length of extension into the furnace.

A.5.1.18 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 pipe extending away from the furnace, a requirement which is identical between the AS1530.4- 1997 and AS1530.4- 2005 standards.

A.5.2 Application of Test Data to AS1530.4-2005.

A.5.2.1 The variations in furnace heating regimes and the responses of the different thermocouple types to the furnace conditions are not expected to have significant effect on the outcome of the referenced fire resistance test. The difference in size requirements has been concluded to be insignificant for the specimen configurations in the reference tests.

A.5.2.2 It is confirmed that the data referenced in FSV 1025 and FSH 1028 can be used to determine the likely conduction properties of the plasterboard if tested in accordance with AS1530.4-2005.

A.6 TEST REPORT – 283513/3313FR

A.6.1 Test Sponsor

A.6.1.1 HILTI Entwicklungsgesellschaft mbH, Hiltistrabe 6, 86916 Kaufering Germany.

A.6.2 Test Laboratory

A.6.2.1 Istituto Giordano S.p.A, Via Rossini, 2 – 47814 Bellaria Marina (RN), Italy.

A.6.3 Date of Test

A.6.3.1 The fire resistant test was conducted on 16th June 2011.

A.6.4 Test Method

A.6.4.1 It is tested in accordance with EN 1363-1:2001 and EN 1366-3:2009

A.6.5 Summary of test:

A.6.5.1 The test assembly comprised a 3200mm high × 3200mm wide plasterboard lined wall with a wall thickness of 100mm thick incorporating two layers of 12.5mm thick fire rated plasterboard each side of the steel studs. The wall cavity was filled with Rockwool insulation with a density of 100kg/m³.

A.6.5.2 The wall was penetrated by various diameter pipe penetrations protected by CFS-C P and CFS-S ACR firestop collars that were installed on both sides of the wall.

A.6.5.3 At the request of the sponsor, only Penetration 16, 17 and 19 from this test report are considered in the assessment.

A.6.5.4 The above three pipes penetrated into the furnace by at least 500mm and extended out from the unexposed face by at least 500. All pipes were capped on the exposed face. The penetrations were supported at 350mm on the exposed side and at 300mm and 450mm on the unexposed side.

A.6.5.5 The assemblies of specimen 16, 17 and 19 are summarized below:

Service No.	Pipe Material	Pipe Size	Collar Type	Annular Gap Size (mm)	Annular Gap Protection	Insulation
16	RAUPIANO Plus PP	Ø50 (OD) × 1.8mm	CFS-CP 50/1.5 both sides	11	CFS- S ACR sealant to full depth of wall lining	Wrapped with 9mm Therma-compact between wall and pipe
17	RAUPIANO Plus PP	Ø75 (OD) × 1.9mm	CFS-CP 75/2.5 both sides	8.5	CFS- S ACR sealant to full depth of wall lining	Wrapped with 9mm Therma-compact between wall and pipe
19	RAUPIANO Plus PP	Ø110 (OD) × 2.7mm	CFS-CP 110/4 both sides	16	CFS- S ACR sealant to full depth of wall lining	Wrapped with 9mm Therma-compact between wall and pipe

A.6.5.6 The test was terminated after a period of 132 minutes.

A.6.5.7 The ambient temperature of the test was 21°C/

A.6.5.8 The fire resistance performance of the penetrations is summarised below.

Service No.	Structural Adequacy	Integrity (min)	Insulation (min)
16	Not Applicable	No failure at 132 minutes	No failure at 132 minutes
17	Not Applicable	No failure at 132 minutes	No failure at 132 minutes
19	Not Applicable	No failure at 132 minutes	No failure at 132 minutes

A.7 TEST REPORT – 285773/3333FR

A.7.1 Test Sponsor

A.7.1.1 HILTI Entwicklungsgesellschaft mbH, Hiltistrabe 6, 86916 Kaufering Germany.

A.7.2 Test Laboratory

A.7.2.1 Istituto Giordano S.p.A, Via Rossini, 2 – 47814 Bellaria Marina (RN), Italy.

A.7.3 Date of Test

A.7.3.1 The fire resistant test was conducted on 16th June 2011.

A.7.4 Test Method

A.7.4.1 It is tested in accordance with EN 1363-1:2001 and EN 1366-3:1999

A.7.5 Summary of test:

A.7.5.1 The test assembly comprised a 150mm thick concrete floor slab penetrated by various diameter pipe penetrations protected by firestop collars on the underside of the slab.

A.7.5.2 At the request of the sponsor, only Penetration 16, 17 and 19 from this test report are considered in the assessment.

A.7.5.3 The above three pipes penetrated into the furnace by at least 500mm and extended out from the unexposed face by at least 500. All pipes were capped on the exposed face. The penetrations were supported at 300mm and 450mm on the unexposed side.

A.7.5.4 The above mentioned pipe penetration assemblies are summarized below:

Service No.	Pipe Material	Pipe Size	Collar Type	Insulation	Annular Gap Size (mm)	Annular Gap Protection
16	RAUPIANO Plus PP	Ø50 (OD) × 1.8mm	CFS-CP 50/1.5	Wrapped with 9mm Therma-compact between wall and pipe	11	10mm deep CFS-S ACR sealant on unexposed side and backed with mineral wool
17	RAUPIANO Plus PP	Ø75 (OD) × 1.9mm	CFS-CP 75/2.5		8.5	10mm deep CFS- S ACR sealant on unexposed side and backed with mineral wool
19	RAUPIANO Plus PP	Ø110 (OD) × 2.7mm	CFS-CP 110/4		16	10mm deep CFS- S ACR sealant on unexposed side and backed with mineral wool

A.7.5.5 The test was terminated after a period of 198 minutes.

A.7.5.6 The ambient temperature of the test was 21°C.

A.7.5.7 The fire resistance performance of the penetrations is summarised below.

Service No.	Structural Adequacy	Integrity (min)	Insulation (min)
16	Not Applicable	No failure at 198 minutes	No failure at 198 minutes
17	Not Applicable	No failure at 198 minutes	No failure at 198 minutes
19	Not Applicable	No failure at 198 minutes	No failure at 198 minutes

A.8 TEST REPORT – MPA 3209/3045

A.8.1 Test Sponsor

A.8.1.1 HILTI Entwicklungsgesellschaft mbH, Hiltistrabe 6, D-86916 Kaufering Germany.

A.8.2 Test Laboratory

A.8.2.1 MPA BRAUNSCHWEIG

A.8.3 Date of Test

A.8.3.1 The fire resistant test was conducted on 3rd May 2005.

A.8.4 Test Method

A.8.4.1 It is tested in accordance with DIN 4102-11:1985-12.

A.8.5 Summary of test:

A.8.5.1 The test assembly comprised a 4000mm long × 2400mm wide × 150mm thick concrete floor slab penetrated by various diameter pipe penetrations protected by firestop collars fixed on the underside of floor slab.

A.8.5.2 At the request of the sponsor, only Penetration 14, 15 and 16 from this test report are considered in the assessment.

A.8.5.3 All the pipes penetrated into the furnace by at least 525 mm and extended out from the unexposed face by at least 525mm. All pipes were capped on the exposed face and supported on the unexposed side at 300mm and 450mm.

A.8.5.4 The above mentioned pipe penetration assemblies are summarized below:

Service No.	Pipe Material	Pipe Size	Collar Type	Annular Gap Protection
14	RAUPIANO Plus PP	Ø50 (OD) × 1.8mm	CFS-CP 50/1.5	Gap filled with mortar between pipe and floor
15	RAUPIANO Plus PP	Ø110 (OD) × 2.7mm	CFS-CP 110/4	
16	RAUPIANO Plus PP	Ø125 (OD) × 3.1mm	CFS-CP 125/5	

A.8.5.5 The test was terminated after a period of 100 minutes.

A.8.5.6 The fire resistance performance of the penetrations is summarised below.

Service No.	Structural Adequacy	Integrity (min)	Insulation (min)
14	Not Applicable	No failure at 100 minutes	No failure at 100 minutes
15	Not Applicable	No failure at 100 minutes	No failure at 100 minutes
16	Not Applicable	No failure at 100 minutes	No failure at 100 minutes

A.9 TEST REPORT – 283512/3312FR

A.9.1 Test Sponsor

A.9.1.1 HILTI Entwicklungsgesellschaft mbH, Hiltistrabe 6, 86916 Kaufering Germany.

A.9.2 Test Laboratory

A.9.2.1 Istituto Giordano S.p.A, Via Rossini, 2 – 47814 Bellaria Marina (RN), Italy.

A.9.3 Date of Test

A.9.3.1 The fire resistant test was conducted on 16th May 2011.

A.9.4 Test Method

A.9.4.1 It is tested in accordance with EN 1363-1:2001 and EN 1366-3:2009

A.9.5 Summary of test:

A.9.5.1 The tested assembly comprised of 17 round opening in a 100mm thick steel framed wall clad with two layers of nominal 12.5mm thick type F gypsum plasterboard and the wall cavity was filled with 50mm thick Rockwool panel with a density of 100kg/m³.

A.9.5.2 The wall was penetrated by various pipe type penetrations protected by CFS-C P fire stop collars and CFS-S ACR sealant or gypsum on each side of the wall.

A.9.5.3 For the purpose of the assessment, only penetrations 34, 35, 36 and 37 are relevant.

A.9.5.4 The above four CPVC pipes penetrated extended 500mm on both sides of wall construction. The pipes were supported on the unexposed side at 3000mm and 450mm and on the exposed side at 350mm.

A.9.5.5 The assemblies of specimen 34, 35, 36 and 37 are summarized below:

ID	Pipe Material	Pipe Size (OD)	Aperture Size	Collar Code	Pipe Insulation*	Annular Gap Size	Annular Gap Protection
34	FRIATH-ERM starr	Ø32 × 3.6mm	Ø90mm	50/1.5"	9mm thick ARMAFLEX AF	20mm	CFS-S ACR sealant to the depth of wall lining each side
35	FRIATH-ERM starr	Ø42 × 4.5mm	Ø100mm	63/2"	9mm thick ARMAFLEX AF	20mm	CFS-S ACR sealant to the depth of wall lining each side
36	FRIATH-ERM starr	Ø52 × 5.6mm	Ø110mm	63/2"	9mm thick ARMAFLEX AF	20mm	plaster to the depth of wall lining each side
37	FRIATH-ERM starr	Ø63 × 7.1mm	Ø130mm	75/2"	10mm thick ARMAFLEX AF	23.5mm	CFS-S ACR sealant to the depth of wall lining each side

*the CPVC pipes were wrapped with Armaflex AF insulation with 250mm extension each side of the wall.

A.9.5.6 The pipes were uncapped on the unexposed side and capped on the unexposed side.

A.9.6 Instrumentation

A.9.6.1 The instrumentation was provided and applied in accordance with EN 1363-1.

A.9.7 Test Results

A.9.7.1 The test was terminated after a period of 133 minutes.

A.9.7.2 Ambient temperature in the vicinity of the test construction was 19°C at the start of the test.

A.9.7.3 During the test, an average pressure of 10Pa recorded in the penetration placed the lowest.

A.9.7.4 The fire resistance performance of the penetrations is summarised below.

Service No.	Structural Adequacy	Integrity (min)	Insulation (min)
34	Not Applicable	No failure at 133 minutes	No failure at 132 minutes
35	Not Applicable	No failure at 133 minutes	No failure at 132 minutes
36	Not Applicable	No failure at 133 minutes	No failure at 132 minutes
37	Not Applicable	No failure at 133 minutes	No failure at 132 minutes

A.10 RELEVANCE OF 1363-1: 1999 TEST DATA WITH RESPECT TO AS1530.4-2005

A.10.1 General

A.10.1.1 The fire resistance tests 283513/3313FR, 285773/3313FR and 283512/3312FR were conducted in accordance with EN 1363-1:2001 and EN 1366-3:1999. These standards differ from AS1530.4-2005 and the significance of these differences is discussed below.

Temperature Regime

A.10.1.2 The furnace temperature regime for fire resistance tests conducted in accordance with AS 1530.4-2005 follows the same trend as EN1363-1:2001

A.10.1.3 The parameters outlining the accuracy of control of the furnace temperature in AS 1530.4-2005 and EN1363-1:2001 are not appreciably different.

Furnace Thermocouples

A.10.1.4 The furnace thermocouples specified in AS1530.4-2005 are type K, mineral insulated metal sheathed (MIMS) with a stainless steel sheath having a wire of diameter of less than 1.0mm and an overall diameter of 3mm. The measuring junction protrudes at least 25mm from the supporting heat resistant tube.

A.10.1.5 The furnace thermocouple specified in EN1363.1:2001 is made from folded steel plate that faces the furnace chamber. A thermocouple is fixed to the side of the plate facing the specimen with the thermocouple hot junction protected by a pad of insulating material.

A.10.1.6 The plate part is to be constructed from 150 ±1 mm long by 100 ±1 mm wide by 0.7 ±0.1 mm thick nickel alloy sheet strips.

A.10.1.7 The measuring junction is to consist of nickel chromium/nickel aluminium (Type K) wire as defined in IEC 60584-1, contained within mineral insulation in a heat-resisting steel alloy sheath of nominal diameter 1 mm, the hot junctions being electrically insulated from the sheath.

A.10.1.8 The thermocouple hot junction is to be fixed to the geometric centre of the plate, by a small steel strip made from the same material as the plate. The steel strip can be welded to the plate or may be screwed to it to facilitate replacement of the thermocouple. The strip should be approximately 18 mm by 6 mm if it is spot-welded to the plate, and nominally 25 mm by 6 mm if it is to be screwed to the plate. The screw is to be 2 mm in diameter.

A.10.1.9 The assembly of plate and thermocouple should be fitted with a pad of inorganic insulation material 97 ±1 mm by 97 ±1 mm by 10 ±1 mm thick with a density of 280 ±30 kg/m³.

A.10.1.10 The relative location of the furnace thermocouples for the exposed face of the specimen, for AS1530.4-2005 and EN1363.1:2001, is 100mm +10mm and 100mm +50mm respectively.

A.10.1.11 The furnace control thermocouples required by EN1363.1:2001 are less responsive than those specified by AS1530.4-2005. This variation in sensitivity can produce a potentially more onerous heating condition for specimens tested to EN1363.1:2001, particularly when the furnace temperature is changing quickly in the early stages of the test.

Specimen Thermocouples

A.10.1.12 For penetration sealing systems, thermocouples are fixed in generally similar locations on the unexposed face: on the supporting construction and/or seal and on the penetrating service adjacent at the plane of penetration, and on the penetrating service some distance from the plane of penetration.

Furnace Pressure

A.10.1.13 It is a requirement of AS1530.4-2005 and for EN1363-1:2001 that for vertical elements, a furnace gauge pressure of 15+3 Pa is established at the centre of lowest penetration.

A.10.1.14 It is a requirement of AS1530.4-2005 and for EN1363-1:2001 that for horizontal elements, a furnace gauge pressure of 20Pa is established at a height 100mm below the floor soffit level.

A.10.1.15 The parameters outlining the accuracy of control of the furnace pressure in AS1530.4-2005 and EN1363-1:1999 are also not appreciably different.

Performance Criteria

A.10.1.16 AS 1530.4-2005 specifies the following performance criteria for building materials and structures:

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

- Integrity
- Insulation

Integrity Performance Criteria

- A.10.1.17 The integrity criteria differ slightly between AS1530.4-2005 and EN 1363-1:2001.
- A.10.1.18 While a specimen maintains its insulation performance, the specimen shall be deemed to have failed the integrity criterion in accordance with EN 1363-1:2001 if it collapses or sustains flaming or other conditions on the unexposed face, which ignite the cotton pad when applied for up to 30 seconds.
- A.10.1.19 A specimen shall be deemed to have failed the integrity criterion in accordance with AS1530.4-2005 when any of the following occur:
- A.10.1.20 Sustained flaming for 10 seconds.
- A gap forms that allows the passage of hot gases to the unexposed face and ignite the cotton pad when applied for up to 30 seconds.
 - A gap forms that allows the penetration of a 25mm gap gauge anywhere on the specimen
 - A gap forms that allows a 6mm by 150mm gap gauge to penetrate the specimen anywhere on the specimen.
- A.10.1.21 Except for minor technical variation, the integrity criteria in EN 1363.1:1999 are generally applied in a comparable manner.

Insulation Performance Criteria

- A.10.1.22 Apart from the variation in specimen thermocouple locations, the insulation criteria for AS1530.4-2005 and EN1363-1:2001 are not appreciably different.

Specimen Configuration, Support and End Conditions

- A.10.1.23 AS 1530.4-2005 requires the plastic pipes extend on the fire side by 500mm and to extend on the non-fire side by 2000mm and tested capped on the fire side and uncapped on the non-fire side.
- A.10.1.24 EN1366-3 also requires the pipes extend on the fire side and non-fire side by a minimum of 500mm.
- A.10.1.25 With reference to test reports 283513/3313FR and 285773/3313FR, the relevant tested pipe specimens were tested capped on the exposed side and uncapped on the unexposed side. Pipes extended 500mm on each side.
- A.10.1.26 With reference to test report 283512/3312FR, the relevant tested pipe specimens were tested uncapped on the exposed side and capped on the unexposed side. Pipes extended 500mm on each side.
- A.10.1.27 The influence of this difference will be discussed on a case to case basis.

A.10.2 Application of Test Data to AS1530.4-2005

- A.10.2.1 The variations in furnace heating regimes, furnace thermocouples and the responses of the different thermocouple types to the furnace conditions are not expected to have significant effect on the outcome of the referenced fire resistance test.
- A.10.2.2 AS1530.4-2005 specifics for general pipe systems [e.g., SWV (soil waste vent), water supply and reticulation] the fire side capped/non-fire side open configuration shall be adopted.
- A.10.2.3 In this report the application of the CPVC pipe is for water supply systems only. In this case capping on the non-fire side is representative of this type of application
- A.10.2.4 It is therefore considered the CPVC pipes tested in 283512/3312FR tested capped on the unexposed side and uncapped on the exposed side is applicable to water supply systems only and the pipe extension on the non-fire side will not affect the performance of the penetration.
- A.10.2.5 With regards to the plastic pipes tested in 283513/3313FR, 285773/3313FR the pipe extensions on the non-fire side were 500mm away from the walls and floors rather than 2000mm required by AS1530.4-2005.

- A.10.2.6 Theoretically, this difference in extension can affect the drawing of hot gases through the pipe by a 'stack effect' and can lead to high temperatures on the non-fire side of the specimen than for a shorter pipe extension.
- A.10.2.7 The impact of the stack effect on the tested services can be significant when there are gaps at the penetrations and hot gases are passing in the pipes and in particular for floor specimens. The longer the length of pipe above the collar is the greater the increase in pressure across the collar or gap.
- A.10.2.8 For the constructions tested in 283513/3313FR, specimens 16, 17, and 19 were tested capped on the exposed side and uncapped on the unexposed side. Around 5 to 10 minutes, the CP 644 collars reacted and filled the aperture thereby reducing the smoke emissions. The pipes did not vent volumes of smoke for the rest duration of the test.
- A.10.2.9 For the construction tested in 285773/3333FR, specimen 16, 17 and 19 were tested capped on the exposed side and uncapped on the unexposed side. At the early stage of the test around 5 to 10 minutes, the CP 644 collars reacted and filled the aperture thereby reducing the smoke emissions. By inspection of test observations, the pipes did not vent volumes of smoke for the rest duration of the test.
- A.10.2.10 The significant of the above observation are that the performance of the specimens and lack of gaps and smoke emission indicates that for the same period the influence of the stack effect would be minimal.
- A.10.2.11 With exception of the variation to the specimen construction requirements the results of the tests 283513/3313FR, 285773/3313FR and 283512/3312FR can be used to assess the FRL of the services in accordance with AS1530.4-2005 up to at least 120 minutes.

A.11 RELEVANCE OF DIN 4102 PART 11:1985 TEST DATA TO AS 1530.4-2005

A.11.1 General

- A.11.1.1 The fire resistance test MPA 3209/3045 was conducted in general accordance with DIN 4102 Part 11:1985. The requirements of these standards differ from AS1530.4-2005. The effect these differences have on fire resistance performance is discussed below.

Temperature Regime

- A.11.1.2 The furnace temperature regime for fire resistance tests conducted in accordance with AS 1530.4-2005 follows a similar trend to DIN 4102 Part 11:1985.
- A.11.1.3 The parameters outlining the accuracy of control of the furnace temperature in AS 1530.4-2005 and DIN 4102 Part 11:1985 are not appreciably different.

Furnace Thermocouples

- A.11.1.4 The furnace thermocouples specified in AS 1530.4-2005 are type K, mineral insulated metal sheathed (MIMS) with a stainless steel sheath having a wire of diameter of less than 1.0mm and an overall diameter of 3mm. The measuring junction protrudes at least 25mm from the supporting heat resistant tube.
- A.11.1.5 The furnace thermocouple types in DIN 4102 Part 11:1985 is of the jacketed type in accordance with DIN 43710, of outside diameter 3.2mm and with at least 25mm of exposed measuring tip.
- A.11.1.6 The response of the different thermocouple types to the furnace conditions is not expected to have significantly affected the recorded test result.
- A.11.1.7 Variations due to the difference in heat transfer conditions between furnaces (which are not fully controlled by the current fire resistance test standards) would be more likely to influence results rather than the minor differences in the thermocouple construction described as above.

Furnace Pressure

- A.11.1.8 It is a requirement of AS1530.4-2005 that for horizontal elements, a furnace gauge pressure of 20Pa is established at a position 100mm below the underside of the test specimen.
- A.11.1.9 DIN 4102 Part 11:1985, a pressure of is maintained at 10Pa at the middle of the longitudinal sides of the test specimen about 100mm from the surface exposed to the flames.

A.11.1.10 Therefore, based on test report AS1530.4-2005 would require the pressure to be approximately 10Pa higher than DIN 4102 Part 11: 1985, which can be more onerous.

Performance Criteria

A.11.1.11 AS 1530.4-2005 specifies the following performance criteria for service penetrations:

- Integrity
- Insulation

Integrity

A.11.1.12 The integrity criteria of AS 1530.4-2005 and DIN 4102 Part 11:1985 are not appreciably different.

Insulation

A.11.1.13 The insulation criteria of AS 1530.4-2005 and DIN 4102 Part 11: 1985 are not appreciably different.

A.11.2 Application of Test Data from MPA 3209/3045 to AS 1530.4-2005

A.11.2.1 The variations in furnace heating regimes, furnace thermocouples, and the responses of the different thermocouple types to the furnace conditions are not expected to have a significant effect on the outcome of the referenced fire resistance test.

A.11.2.2 The variations in furnace pressure condition can be more onerous and could affect the collar closure time of the test specimen. The effect of lower furnace pressure condition will be discussed by a case to case basis.

A.11.2.3 Based on the above discussion, it is considered that the results relating to the integrity and insulation performance of the Rehau RAUPIANO Plus pipes in MPA 3209/3045 can be used to assess the integrity and insulation performance of tested specimen in accordance with AS1530.4-2005 for up to 100 minutes.

A.12 RELEVANCE OF AS1530.4-2005 TEST DATA TO AS15340.4-2014

A.12.1 General

A.12.1.1 The fire resistance tests FSRG A-15-982, FSRG A-07-515 and EWFA 2683500 were conducted in accordance with AS1530.4-2005, which differs from AS1530.4-2014. The effect these differences have on fire resistance performance of the referenced test specimens is discussed below.

A.12.2 Discussion

Temperature Regime

A.12.2.1 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.

A.12.2.2 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_0	=	initial furnace temperature, in degrees Celsius, such that
t	=	the time into the test, measured in minutes from the ignition of the furnace

A.12.2.3 The parameters outlining the accuracy of control of the furnace temperature in AS 1530.4-2014 and AS 1530.4-2005 are not appreciably different.

Furnace Pressure

A.12.2.4 The furnace pressure conditions for single and multiple penetration sealing systems in AS1530.4-2005 and AS1530.4-2014m are not appreciably different,

A.12.2.5 The parameters outlining the accuracy of control of the furnace pressure in AS1530.4-2014 and AS1530.4-2005 are not appreciably different.

Performance Criteria

A.12.2.6 AS 1530.4-2014 specifies the following performance criteria for building materials and structures:

- Structural Adequacy (not relevant)
- Integrity
- Insulation

Integrity

A.12.2.7 AS1530.4-2014 stipulates in addition to the 20mm thick x 100mm x 100mm cotton pads additional cotton pads shall be provided with a reduced 30mm x 30mm x 20mm with additional wire frame holder shall be used to determine integrity failure.

A.12.2.8 Apart from the above variation, the failure criteria for integrity in AS1530.4-2014 and AS1530.4-2005 are not appreciably different.

Insulation

A.12.2.9 The positions of thermocouples and failure criteria for insulation in AS 1530.4-2014 and AS 1530.4-2005 are not appreciably different.

A.12.3 Application of Test Data to AS1530.4-2014.

A.12.3.1 There is a difference in cotton pad size between standards, however it is confirmed that the variation does not affect the integrity performance of the tested penetrations in the referenced tests for at least 120 minutes.

A.12.3.2 Based on the above, discussion and in absence of any foreseeable integrity and insulation risk, it is considered that the results relating to the integrity and insulation performance of the specimens tested in FSRG A-15-982, FSRG A-07-515 and EWFA 2683500 can be used to assess the integrity and insulation performance in accordance with AS1530.4-2014.

APPENDIX B - ASSESSMENT OF SPECIFIC VARIATIONS

B.1 UPVC PIPES PROTECTED WITH HILTI RETROFIT FIRESTOP COLLAR

B.1.1 Proposal

B.1.1.1 The proposed construction with reference to tests FSV 1025 and FSH 1028 shall be tested with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in lieu of collar CP 643.

B.1.2 Discussion

B.1.2.1 The penetration systems in tests FSV 1025 and FSH 1028 comprised uPVC pipes of various diameters and wall thicknesses. They were tested in walls and floors respectively.

B.1.2.2 When tested in FSV 1025 the specimen achieved 120 minutes integrity and between 108 and 120 minutes insulation.

B.1.2.3 When tested in FSV 1028 the specimen achieved 240-minute integrity and 240-minute insulation.

B.1.2.4 The proposed CP644 collars are very similar in construction to the CP643 collars, having the same outer shell and a high specification intumescent.

B.1.2.5 By observation the CP 643 and CFS-C P/CP 644 collars are similar in appearance and function. The manufacturer of the collar has confirmed that the key difference is that the intumescent of the CFS-C P/CP 644 collar is stronger or more voluminous than the intumescent in the CP 643 collar. The collars are otherwise constructed and fitted to a similar specification.

B.1.2.6 The CP643 and CP644 Firestop jackets are shown below.



Figure B1.1 – CP 643 Firestop Jacket



Figure B1.2 – Hilti Retrofit Firestop Collar CFS-C P/CP 644

B.1.2.7 Based on the similarity of the construction of the CP643 and CP644 it is expected that the specimens tested in FSV 1025 and FSH 1028 would achieve a similar performance if the CP644 collars were used in lieu of CP643 collars.

B.1.2.8 Based on the above discussion it is considered that CP 643 collars tested in FSV 1025 and FSH 1028 can be replaced with CP644 collars without detrimentally affecting their performance if tested in accordance with AS1530.4-2005.

B.1.2.9 The expected performance of CP644 Collars is summarised below:

Table B1.1 Assessed Performance of uPVC pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in walls

Outside Diameter Size (mm)	Pipe Wall Thickness (mm)	Collar Size	Integrity (min)	Insulation (min)
43	2.0	50/1.5"	120	114 min on collar
56	2.2	63/2"	120	120
69	2.7	75/2.5"	120	115 min on collar
85	2.9	90/3"	120	108 min on pipe
111	3.2	110/4"	120	120
160	4.5	160/6"	120	120

Table B1.2 Assessed Performance of uPVC pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in floors

Pipe Outside Diameter Size (mm)	Pipe Wall Thickness (mm)	Collar Size	Integrity (min)	Insulation (min)
43	2.0	50/1.5"	240	240
56	2.2	63/2"	240	240
69	2.7	75/2.5"	240	240
85	2.9	90/3"	240	240
111	3.2	110/4"	240	240
160	4.5	160/6"	240	240

B.2 PPR PIPES PROTECTED WITH HILTI RETROFIT FIRESTOP COLLAR

B.2.1 Proposed Construction

B.2.1.1 The proposed construction comprises Hilti Retrofit Firestop Collar CFS-C P/CP 644 protecting PPR pipes in walls and floors. The Pipe and collar sizes are shown below.

Pipe Material	Local Fire Stopping System	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)
PPR PIPE	Hilti Retrofit Firestop Collar CFS-C P/CP 644	40	6
		50	6.9
		65	8.6
		80	10.3
		100	12.3
		110	15
		125	19

B.2.2 Discussion

Pipes in Walls

B.2.2.1 With reference to Section B.1 it is confirmed that uPVC pipes in the range 40mm to 100mm protected with CFS-C P/CP 644 collars fitted to a steel framed plasterboard wall will achieve FRL performance are summarised in Table B.2.1 when tested in accordance with AS 1530.4-2005.

B.2.2.1 PPR Ø40mm, Ø110mm and Ø125mm pipes were tested in EWFA 2626600.4 that were protected with CFS-C P/CP 644 collar fixed on each sides of the plasterboard wall. When tested, the Ø40mm, Ø110mm and Ø125mm pipes achieved an integrity performance of 195 minutes integrity, and insulation performance for 163, 162 and 188 minutes insulation respectively.

B.2.2.2 It is confirmed that when tested in a slightly thicker 128mm thick wall the PPR pipes demonstrated a significantly improved insulation performance when compared with the uPVC pipes tested in FSV 1025.

B.2.2.3 It is expected that the intermediate sizes of pipe between 40mm and 110mm would also demonstrated a similar improvement of their insulation performance. The variation in insulation performance of the uPVC pipes tested was 12 minutes.

B.2.2.4 The margin of insulation performance above 120 minutes for the PPR pipes was 162 and 163 minutes for 40mm and 110mm diameter pipes.

- B.2.2.5 Clause 4.6.4 of AS 4072.1- 2005 states test results from tests of uPVC pipes in the range of 40mm to 120mm can be applied to the intermediate pipe sizes of another pipe material provided the maximum and minimum pipe of the new material are tested and achieve at least the performance of the tested uPVC pipes.
- B.2.2.6 Based on the discussion above, it is considered that PPR pipes in the range 40mm to 125mm will achieve fire resistance performance summarised below if protected with CFS-C P/CP 644 collars on both sides of the plasterboard wall 116mm and 128mm thick if tested in accordance with AS 1530.4-2014.

Table B2.1 – Performance of PPR pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in walls

Pipe Material	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)	FRL
PPR pipe	40	6	-/120/120
	50	6.9	-/120/120
	65	8.6	-/120/120
	80	10.3	-/120/120
	100	12.3	-/120/120
	110	15	-/120/120
	125	19	-/120/120

Pipes in Floors

- B.2.2.1 With reference to Section B.1 it is confirmed that uPVC pipes in the range 40mm to 100mm protected with CFS-C P/CP 644 collars fitted to the underside of a 150mm concrete slab will achieve FRL performance are summarised in Table B.2.2 when tested in accordance with AS 1530.4-2005.
- B.2.2.2 PPR with nominal diameter Ø40mm, Ø110mm and Ø125mm pipes were tested in EWFA 2626601.2 that were protected with CFS-C P/CP 644 collars fixed to the underside of the slab. When tested the Ø40mm, Ø110mm and Ø125mm pipes achieved an integrity performance of 216, 176 and 241 minutes integrity and 177, 176 and 173 minutes insulation respectively.
- B.2.2.3 It is confirmed that when tested in a slightly thinner 120mm thick slab the PPR pipes demonstrated an insulation performance in excess of 120 minutes and a margin of 53 to 57 minutes and a small variation in insulation performance.
- B.2.2.4 It is considered for 120mm thick floor slabs the insulation performance of the intermediate pipes would exceed 120 minutes by some margin.
- B.2.2.5 Clause 4.6.4 of AS 4072.1- 2005 states test results from tests of PVC pipes in the range of 40mm to 120mm can be applied to the intermediate pipe sizes of another pipe material provided the maximum and minimum pipe of the new material are tested and achieve at least the performance of the tested PVC pipes
- B.2.2.6 With reference to section B1 it is confirmed that uPVC pipes in the range 40mm to 100mm protected with CFS-C P/CP 644 collar fitted to the exposed side of a concrete floor of thickness 150mm will achieve FRL of up to 240 minutes integrity and insulation performance if tested in accordance with AS 1530.4-2005.
- B.2.2.7 With reference to EWFA 2626601.2, the PPR pipe of size 40mm and 110mm achieved the fire resistance performance of -/120/120.
- B.2.2.8 Based on the above discussion it is considered that the proposed PPR pipes of diameters between 40mm and 110mm will achieve the integrity and insulation performance of at least 120 minutes.
- B.2.2.9 Based on the discussion above it is considered for PPR pipes in the range 40mm-125mm and the proposed intermediate pipes protected with CFS-C P/CP 644 collars on the exposed side will achieve fire resistance performance shown below if tested in accordance with AS 1530.4-2005.

Table B2.2 – Performance of PPR pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in floors

Pipe Material	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)	FRL
PPR pipe	40	6	-/180/120
	50	6.9	-/120/120
	65	8.6	-/120/120
	80	10.3	-/120/120
	100	12.3	-/120/120
	110	15	-/120/120
	125	19	-/240/120

B.3 PE-100 PIPES PROTECTED WITH HILTI RETROFIT FIRESTOP COLLAR

B.3.1 Proposed Construction

B.3.1.1 The proposed construction shall be as tested for the PE-100 pipes is summarised below

Pipe Material	Local Fire Stopping System	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)
PE-100	Hilti Retrofit Firestop Collar CFS-C P/CP 644	40	5
		50	4.6
		65	5.8
		80	6.8
		100	8.2
		110	12
		125	13
		200	20

B.3.2 Discussion

Pipes in Walls

B.3.2.1 With reference to Section B.1 it is confirmed that uPVC pipes in the range 40mm to 100mm protected with CFS-C P/CP 644 collars fitted to a steel framed plasterboard wall will achieve FRL performance are summarised in Table B.2.1 when tested in accordance with AS 1530.4-2005.

B.3.2.2 PE-100 Ø40mm, Ø110mm, Ø125mm and Ø200mm pipes were tested in EWFA 2626600.4 that were protected with CFS-C P/CP 644 collar fixed on each sides of the plasterboard wall. When tested, Ø40mm, Ø110mm and Ø125mm pipes achieved an integrity performance of 182 to 195 minutes integrity and an insulation performance of 147 to 159 minutes.

B.3.2.3 It is confirmed that when tested in a slightly thicker 128mm thick wall the PE-100 pipes demonstrated a significantly improved insulation performance when compared with the uPVC pipes tested in FSV 1025.

B.3.2.4 It is expected that the intermediate sizes of pipe between 40mm and 110mm would also demonstrated a similar improvement of their insulation performance. The variation in insulation performance of the uPVC pipes tested was 12 minutes.

B.3.2.5 The margin of insulation performance above 120 minutes for the PE-100 pipes was 39 and 27 minutes for 40mm and 110mm diameter pipes respectively

- B.3.2.6 It is considered for 128mm partitions that the insulation performance of the intermediate pipes could vary though based the variation of uPVC pipes it is not expected to vary more than 27 minutes.
- B.3.2.7 Clause 4.6.4 of AS 4072.1- 2005 states test results from tests of uPVC pipes in the range of 40mm to 120mm can be applied to the intermediate pipe sizes of another pipe material provided the maximum and minimum pipe of the new material are tested and achieve at least the performance of the tested uPVC pipes.
- B.3.2.8 For pipes greater than 120mm in diameter it is expected that the performance could possibly be slightly reduced if installed within narrower partition.
- B.3.2.9 However based on the above discussion and the margin demonstrated over integrity an insulation it is considered the proposed 125mm and 200mm pipe would achieve 180 minutes integrity and at least 120 and 60 minutes insulation respectively if tested in a 116mm thick plaster board wall.
- B.3.2.10 Based on the discussion above, it is considered that PE-100 pipes in the range 40mm to 200mm will achieve fire resistance performance summarised below if protected with CFS-C P/CP 644 collars on both sides of the plasterboard wall 116mm (2x13mm) and 128mm (2x16mm) thick if tested in accordance with AS 1530.4-2014.

Table B3.1 – Performance of PE-100 pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in walls

Pipe Material	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)	FRL >128mm Walls
PE-100	40	5	-/120/120
	50	4.6	-/120/120
	65	5.8	-/120/120
	80	6.8	-/120/120
	100	8.2	-/120/120
	110	12	-/120/120
	125	13	-/120/120
	200	20	-/120/60

Pipes in Floors

- B.3.2.11 With reference to Section B.1 it is confirmed that uPVC pipes in the range 40mm to 100mm protected with CFS-C P/CP 644 collars fitted to the underside of a 150mm concrete slab will achieve FRL performance are summarised in Table B.2.2 when tested in accordance with AS 1530.4-2005.
- B.3.2.12 PE-100 with nominal diameter Ø40mm, Ø110mm, Ø125mm and Ø200mm pipes were tested in EWFA 2626601.2 that were protected with CFS-C P/CP 644 collars fixed to the underside of the slab. When tested the Ø40mm, Ø110 and Ø125mm pipes achieved an integrity performance of 210, 107 and 81 minutes integrity and 165, 107 and 81 minutes insulation respectively.
- B.3.2.13 It is considered for 120mm thick floor slabs the insulation performance of the intermediate pipes would exceed 120 minutes by some margin.
- B.3.2.14 Clause 4.6.4 of AS 4072.1- 2005 states test results from tests of uPVC pipes in the range of 40mm to 120mm can be applied to the intermediate pipe sizes of another pipe material provided the maximum and minimum pipe of the new material are tested and achieve at least the performance of the tested uPVC pipes

- B.3.2.15 With reference to section B1 it is confirmed that uPVC pipes in the range 40mm to 100mm protected with CFS-C P/CP 644 collar fitted to the exposed side of a concrete floor of thickness 150mm will achieve FRL of up to 240 minutes integrity and insulation performance if tested in accordance with AS 1530.4-2005.
- B.3.2.16 With reference to EWFA 2626601.2, the PE-100 pipe of size 40mm and 110mm achieved the fire resistance performance of -/180/120 and -/90/90 respectively.
- B.3.2.17 Based on the above discussion it is considered that the proposed PE-100 pipes of diameters between 40mm and 110mm will achieve the integrity and insulation performance of at least 90 minutes.
- B.3.2.18 Based on the discussion above it is considered for PE-100 pipes in the range 40mm-125mm and the proposed intermediate pipes protected with CFS-C P/CP 644 collars on the exposed side will achieve fire resistance performance shown below if tested in accordance with AS 1530.4-2005.

Table B3.2 – Performance of PE-100 pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in concrete floors

Pipe Material	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)	FRL
PE-100	40	5	-/180/120
	50	4.6	-/90/90
	65	5.8	-/90/90
	80	6.8	-/90/90
	100	8.2	-/90/90
	110	12	-/60/60
	125	13	-/30/30

B.4 REHAU RAUPIANO PLUS PIPES PROTECTED WITH HILTI RETROFIT FIRESTOP COLLAR

B.4.1 Proposed Construction

B.4.1.1 The proposed construction shall be as tested for the REHAU RAUPIANO PLUS pipes is summarised below

Pipe Material	Local Fire Stopping System	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)
REHAU RAUPIANO PLUS	Hilti Retrofit Firestop Collar CFS-C P/CP 644	50	1.8
		75	1.9
		90	2.2
		110	2.7

B.4.2 Discussion

Pipes in Floors

B.4.2.1 With reference to Section B.1 it is confirmed that uPVC pipes in the range 40mm to 100mm protected with CFS-C P/CP 644 collars fitted to the underside of a 150mm concrete slab will achieve FRL performance are summarised in Table B.1.2 when tested in accordance with AS 1530.4-2005.

B.4.2.2 REHAU RAUPIANO PLUS pipes with nominal diameter Ø50mm, Ø75mm and Ø110mm pipes were tested in 285773/3333FR that were protected with CFS-C P/CP 644 collars fixed to the underside of a 150mm thick concrete floor slab. When tested the Ø50mm, Ø75 and Ø110mm pipes achieved an integrity performance of 198 minutes integrity and 198 minutes insulation respectively with no sign of impending any integrity or insulation failure during the test duration. The tested specimen insulated with Therma-compact insulation in the gap between pipes and floor slab.

B.4.2.3 REHAU RAUPIANO PLUS pipes with nominal diameter Ø50mm, Ø110mm and Ø125mm pipes were tested in MPA 3209/3045 that were protected with CFS-C P/CP 644 collars fixed to the underside of a 150mm thick concrete floor slab. When tested the Ø50mm, Ø110 and Ø125mm pipes achieved an integrity performance of 110 minutes integrity and 110 minutes insulation respectively with no sign of impending any integrity or insulation failure during the test duration. The gaps between pipes and floor slab were filled with mortar.

B.4.2.4 As discussed previously in Section A10, the furnace pressure in test MPA 3209/3045 was lower than that AS1530.4-2005 required for floor construction. It is considered lower furnace pressure will cause less hot gas passing through the pipes and hence increasing the collar closure time.

B.4.2.5 With reference to the observations of tested REHAU RAUPIANO PLUS pipes tested in test MPA 3209/3045, it was observed the time for the largest Ø125mm REHAU pipe to be closed was around 7 to 8 minutes. It is therefore expected after the pipe was closed; the furnace pressure would have insignificant influence on the behaviour of plastic pipes. It is then considered the temperatures recorded for REHAU RAUPIANO PLUS pipes tested in MPA 3209/3045 at 100 minutes were still valid.

B.4.2.6 The maximum temperatures recorded on the unexposed side for REHAU RAUPIANO PLUS pipes with diameter Ø50mm and Ø110mm for the two testes mentioned above are summarised below:

REHAU RAUPIANO PLUS pipe	Maximum temperature on the unexposed side at 100 minutes	
	With insulation (285773/3333FR)	Without insulation (MPA 3209/3045)
Ø50 × 1.8mm	38°C	49°C
Ø110 × 2.7mm	44°C	55°C

- B.4.2.7 It is observed at 100 minutes, though the pipes insulated with Therma compact insulation are around 10 degrees cooler than that without insulation tested, both constructions had low temperatures and significant margins to fail the insulation of 180K rise.
- B.4.2.8 It is therefore considered the REHAU RAUPIANO PLUS pipes in 285773/3333FR if tested with no insulation filled in the gaps between pipes and floor slab will still achieve 120 minutes insulation performance with margins.
- B.4.2.9 It is also considered for 120mm thick floor slabs the insulation performance of the intermediate pipes would exceed 120 minutes by some margin.
- B.4.2.10 With regards to the plastic pipes tested in 285773/3333FR, their extensions were 525mm away from the walls and floors on unexposed side rather than 2000mm required by AS1530.4-2005.
- B.4.2.11 Theoretically, this difference in extension can affect the drawing of hot gases through the pipe by a "stack effect" and can lead to high temperatures on the non-fire side of the specimen than for a shorter pipe extension.
- B.4.2.12 The impact of the stack effect on the tested services can be significant when there are gaps at the penetrations and hot gasses are passing in the pipes and in particular for floor specimens. The longer the length of pipe above the collar is the greater the increase in pressure across the collar or gap. For walls the stack affect is significant.
- B.4.2.13 For the construction tested in 285773/3333FR, only specimens 16, 17 and 19 are considered in this assessment. Around 10 minutes test duration the collars for specimens 16, 17 and 19 reacted and filled the apertures thereby reducing the smoke emissions. The pipes did not vent volumes of smoke from the end of the pipe.
- B.4.2.14 The significance of the above observations are that the performance of specimen, and the lack of gaps and smoke emission for a significant part of the test indicate that for the same period the influence of the stack effect above the collars would be minimal.
- B.4.2.15 It is therefore considered to be safe to consider the effect of the additional shorter pipe extension in the tested construction will not significantly affect the results of the test up to 198 minutes duration of the test.
- B.4.2.16 Clause 4.6.4 of AS 4072.1- 2005 states test results from tests of uPVC pipes in the range of 40mm to 120mm can be applied to the intermediate pipe sizes of another pipe material provided the maximum and minimum pipe of the new material are tested and achieve at least the performance of the tested uPVC pipes
- B.4.2.17 With reference to section B1 it is confirmed that uPVC pipes in the range 40mm to 100mm protected with CFS-C P/CP 644 collar fitted to the exposed side of a concrete floor of thickness 150mm will achieve FRL of up to 240 minutes integrity and insulation performance if tested in accordance with AS 1530.4-2005.
- B.4.2.18 Based on the discussion above it is considered for REHAU RAUPIANO PLUS pipes in the range 50mm-110mm and the proposed intermediate pipes protected with CFS-C P/CP 644 collars on the exposed side will achieve fire resistance performance shown below if tested in accordance with AS 1530.4-2005.

Table B4.1 – Performance of RAUPIANO PLUS pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in floors

Pipe Material	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)	FRL
RAUPIANO PLUS pipe	50	1.8	-/120/120
	75	1.9	-/120/120
	90	2.2	-/120/120
	110	2.7	-/120/120

Pipes in Walls

- B.4.2.19 With reference to Section B.1 it is confirmed that uPVC pipes in the range 40mm to 100mm protected with CFS-C P/CP 644 collars fitted to a steel framed plasterboard wall will achieve FRL performance are summarised in Table B.2.1 when tested in accordance with AS 1530.4-2005.
- B.4.2.20 REHAU RAUPIANO Plus pipes Ø50mm, Ø75mm and Ø110mm pipes were tested in 283513/3313FR that were protected with CFS-C P/CP 644 collar fixed on each sides of the plasterboard wall. When tested, Ø50mm, Ø75mm and Ø110mm pipes achieved an integrity performance of 132 minutes integrity and an insulation performance of 132 minutes. The tested specimen insulated with Therma compact insulation in the gap between pipes and wall.
- B.4.2.21 With regards to the plastic pipes tested in 283513/3313FR, their extensions were 500mm away from the walls and floors on unexposed side rather than 2000mm required by AS1530.4-2005.
- B.4.2.22 Theoretically, this difference in extension can affect the drawing of hot gases through the pipe by a “stack effect” and can lead to high temperatures on the non-fire side of the specimen than for a shorter pipe extension.
- B.4.2.23 The impact of the stack effect on the tested services can be significant when there are gaps at the penetrations and hot gasses are passing in the pipes and in particular for floor specimens. The longer the length of pipe above the collar is the greater the increase in pressure across the collar or gap. For walls the stack affect is significant.
- B.4.2.24 For the construction tested in 283513/3313FR, only specimens 16, 17 and 19 are considered in this assessment. Around 10 minutes test duration the collars for specimens 16 and 17 reacted and filled the apertures thereby reducing the smoke emissions. The pipes did not vent volumes of smoke from the end of the pipe.
- B.4.2.25 The significance of the above observations are that the performance of specimen, and the lack of gaps and smoke emission for a significant part of the test indicate that for the same period the influence of the stack effect above the collars would be minimal.
- B.4.2.26 It is therefore considered to be safe to consider the effect of the additional shorter pipe extension in the tested construction will not significantly affect the results of the test up to 132 minutes duration of the test.
- B.4.2.27 Similarly to floor construction discussed above, it is therefore considered the REHAU RAUPIANO PLUS pipes in 283513/3313FR if tested with no insulation filled in the gaps between pipes and wall construction will achieve 120 minutes insulation performance with margins.
- B.4.2.28 It is confirmed that when tested in a slightly thicker 128mm thick wall the REHAU RAUPIANO PLUS pipes demonstrated a significantly improved insulation performance when compared with the uPVC pipes tested in FSV 1025.
- B.4.2.29 Clause 4.6.4 of AS 4072.1- 2005 states test results from tests of uPVC pipes in the range of 40mm to 120mm can be applied to the intermediate pipe sizes of another pipe material provided the maximum and minimum pipe of the new material are tested and achieve at least the performance of the tested uPVC pipes.
- B.4.2.30 Based on the discussion above, it is considered that REHAU RAUPIANO PLUS pipes in the range 50mm to 200mm will achieve fire resistance performance summarised below if protected with CFS-C P/CP 644 collars on both sides of the plasterboard wall 116mm if tested in accordance with AS 1530.4-2005.

Table B4.2 – Performance of RAUPIANO PLUS pipes protected with Hilti Retrofit Firestop Collar CFS-C P/CP 644 in walls

Pipe Material	Pipe OD (mm)	Pipe Wall Thickness (mm)	FRL >128mm Walls
RAUPIANO PLUS pipe	50	1.8	-/120/120
	75	1.9	-/120/120
	90	2.2	-/120/120
	110	2.7	-/120/120

B.5 CPVC PIPES PROTECTED WITH HILTI RETROFIT FIRESTOP COLLAR

B.5.1 Proposed Construction

B.5.1.1 The proposed construction comprises Hilti Retrofit Firestop Collar CFS-C P/CP 644 protecting CPVC water supply pipes insulated with Armaflex AF insulation in walls. The pipe sizes and wrapped with Armaflex AF through the wall and 250mm each side are shown below.

Pipe Material	Local Fire Stopping System	Pipe Outside Diameter (mm)	Pipe Wall Thickness (mm)	Insulation Thickness (mm)
CPVC	50/1.5"	26.7	1.9-2.1	9
	50/1.5"	33.4	2.4-2.6	9
	63/2"	42.2	3.1-3.3	9
	75/2.5"	48.3	3.5-3.8	9
	75/2.5"	60.3	4.4-4.7	13

B.5.2 Discussion

B.5.2.1 The four following insulated CPVC pipes were tested in 283512/3312FR and were protected with CFS-C P/CP 644 collar fixed on each side of a 100mm thick steel framed plasterboard lined wall.

Test Reference	Pipe Size	Collar Size	Pipe Insulation	Pipe Insulation Thickness (mm)
283512/3312 FR	Ø32 (OD) × 3.6mm	50/1.5"	Pipe wrapped with Armaflex AF through the wall and 250mm each side	9mm
	Ø42 (OD) × 4.5mm	63/2"		9mm
	Ø52 (OD) × 5.6mm	63/2"		9mm
	Ø63 (OD) × 7.1mm	75/2"		10mm

B.5.2.2 With reference to test 283512/3312FR, the tested four CPVC pipes all maintained integrity and insulation performance of 133 minutes. It is observed the collar was much hotter than the adjacent pipe. This is most easily explained by closure the non-fire side collar around 40 to 50 minutes, thus keeping heat from reaching the non-fire side section of the pipe.

B.5.2.3 As discussed in Appendix A, the tested CPVC pipes were tested capped on the unexposed side and uncapped on the exposed side, hence the CPVC pipes tested in 283512/3312FR are applicable to water supply systems only.

B.5.2.4 The proposed pipes also incorporate CPVC pipes with outside diameter of Ø26.7mm and Ø48.3mm and are protected by Hilti CFS C-P/CP 644 collars in 50/1.5" and 75/2.5" respectively.

B.5.2.5 Upon inspection of the tested observations of the Ø32mm and Ø40mm CPVC pipes tested in 283512/3312FR, the two pipes were protected by 50/1.5" collars on each side and it is noted the temperature rise on the unexposed side of the Ø32 x 3.6mm pipe is around 10 minutes later than the Ø40mm x 4.5 one.

B.5.2.6 The above test results indicates that CPVC pipes when exposed to fire, the fire side protrusion is likely to be charred and stayed in place during the fire exposure and hence gap is unlikely to form between pipe and collar body on the exposed side. The behaviour of CPVC hence indicates CPVC pipe with thicker pipe wall thickness is much more difficult for collars to close off.

B.5.2.7 Based on the above, it is expected the proposed CPVC pipes have smaller outside diameter and thinner pipe wall thickness would maintain similar or no worse integrity and insulation performance to that tested in 283512/3312FR.

B.5.2.8 In light of the above, it is considered the proposed construction will maintain integrity and insulation performance for 120 minutes if tested in accordance with AS1530.4-2014.