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Fire assessment report

Fire resistance performance of FyrePlug Pillows and TWrap insulation protecting services penetrations

Sponsor: Trafalgar Group

Product: Trafalgar FyrePlug Pillows and TWrap insulation

Report number: FAS200048 Revision: R2.1

Issue date: 26 November 2021 Expiry date: 31 May 2025

Amendment schedule

Version	Date	Information relating to report			
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			Prepared by	Reviewed by	Approved by
		Name	Hon Wong	Mahmoud Akl	----------
R1.1	Issue: 27/05/2020	Reason for issue	Revised to include comment from Trafalgar Group		
			Prepared by	Reviewed by	Approved by
		Name	Hon Wong	Mahmoud Akl	Omar Saad
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		Name	Mohamad Mutafi	Mahmoud Akl	Mahmoud Akl
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Executive summary

This report documents the findings of the assessment undertaken to determine the expected resistance level (FRL) of the Trafalgar FyrePlug pillows and Trafalgar TWrap/FyreWrap insulation wrap and various other sealing systems if tested in accordance with AS 1530.4:2014. This assessment was carried out at the request of Trafalgar Group.

The analysis conducted in section 5 of this report found that the proposed variations are likely to achieve the required FRL as shown in Table 1 and Table 2, if tested in accordance with AS 1530.4:2014 and assessed in accordance with AS 4072.1:2005.

Table 1 Assessment outcome of services in wall systems

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation-	FRL
Steel cable tray and Appendix D1 power cables	A 116 mm thick wall that consists of 64 mm steel stud lined with two layers of 13 mm fire rated plasterboard on each side or 120 mm concrete or masonry wall	60 mm Maxilite board in 800 mm × 800 mm aperture	FyreFlex Sealant in joint between plasterboard wall and board on both sides and finished with fillet, in annular gap around service penetration	300 mm single layer on both sides	-/120/120
100 mm O.D × 1.65 mm copper pipe				Insulation wrap arrangement to be revised to be three layers of wrap in the first 100 mm followed with two layers for the next 200 mm followed with single layer for the next 300 mm.	
156 mm O.D × 1.80 mm copper pipe				Insulation wrap arrangement to be revised to be three layers of wrap in the first 100 mm followed with two layers for the next 200 mm followed with single layer for the next 800 mm.	

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation-	FRL
Ø100 mm uPVC SC pipe	78 mm Speedpanel wall system or 75 mm AAC Hebel wall	60 mm thick Maxilite board	Fire collar fitted on pipe at penetration on both sides of wall. FyreFlex sealant applied in apertures	none	-/120/120 in Speedpanel wall -/90/90 in 75 mm AAC Hebel wall
50 mm O.D × 1.2 mm copper pipe			Annular gap was filled with FyreFlex sealant to full depth finished with a 15 mm on each side.	Insulation wrap of 300 mm on fire side and 400 mm on the non-fire side	
Ø60 mm CPVC sprinkler pipe	78 mm Speedpanel wall system	FyreBox Maxi 650 fitted into a 670 mm × 140 mm aperture in the wall	Intumescent strip fitted in the FyreBox. FyreFlex sealant applied in apertures	100 mm wide strip wrap to be tied over the upstand metal angles protruding from wall surface forming a shroud with 25 mm of blanket lapping over wall surface on each side	-/120/120
	75 mm AAC Hebel wall				-/90/90
Appendix D1 power cables on steel cable tray	A 116 mm thick wall that consists of 64 mm steel stud lined with two layers of 13 mm fire rated plasterboard on each side Or 120 mm thick concrete wall	FyrePlug pillows fitted into a 550 mm × 550 mm aperture in the wall	FyreFlex sealant applied in the annular gap between service and FyrePlug Pillows and between cables, cable tray and the FyrePlug pillows	300 mm on each side	-/120/120
100 mm OD copper pipe, including copper, brass or steel pipes up to 100 mm dia. as per clause 10.12.3, AS 1530.4:2014.					
TPS cable bundle					
CAT6 data cables					

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation-	FRL
Appendix D2 bundle of telecom cables on a steel cable tray	Or 95 mm thick plasterboard lined steel stud shaft wall with an established FRL of -/120/120				
100 mm OD copper pipe, including copper, brass or steel pipes up to 100 mm dia. as per clause 10.12.3, AS 1530.4:2014.	Plasterboard wall construction having a pre-established FRL of -/180/180 or concrete/masonry wall of an established FRL of -/180/180			600 mm on both sides of the wall	-/180/180
TPS cable bundle				none	-/120/120
CAT6 data cables				none	-/120/120
DN100 or 100 mm OD Type B copper, copper pipe, including copper, brass or steel pipes up to 100 mm dia. as per clause 10.12.3, AS1530.4:2014.	78 mm Speedpanel wall or 75 mm Hebel AAC wall with	FyrePlug pillows fitted into 1000 mm wide × 300 mm high aperture in the wall	FyreFlex sealant applied in annular gap between service and pillows	First layer for 600 mm followed by a second layer for the first 300 mm only applied on both sides	-/120/120 for Speedpanel walls or -/90/90 for Hebel wall
Bundle of TPS and CAT6 cables				None	
Appendix D1 power cables on a steel cable tray				600 mm on each side	

- The shown FRLs are applicable to Trafalgar FyrePlug pillows in either blue or orange colour.
- The aperture sizes shown across all elements is maximum sizes. The height and/or width of the opening may be varied to a maximum

Table 2 Assessment outcomes in floor systems

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation	FRL
Small steel cable tray and D1 cables	175 mm concrete floor slab	60 mm Maxilite Board over 1000 mm × 300 mm aperture in floor slab	FyreFlex sealant applied in a fillet arrangement around penetration and cable tray and cables on both sides	300 mm plus 300 mm with 50 mm overlap or total of width of 550 mm	-/240/240
2 pair coils, 2 orange power cables and 2 CAT 6 cables	175 mm concrete floor slab	FyreBox Mini 100 in the slot opening in the concrete slab protected all around by FyrePlug pillows friction fitted between the frame of the FyreBox and the slab edge of the floor opening.	Intumescent strips placed in FyreBox. FyreFlex sealant applied between pillows and flanges of the boxes at the interface.	None	-/240/90
				Wrap length of 300 mm. Tie wrap onto the unprotected upstand metal angles all around and extending 25 mm over the top of the pillows.	-/240/180
Drink Python hose		FyreBox Mini 150 fitted into opening in the concrete floor slab	Intumescent strip in Fyreboxes., FyreFlex sealant applied along the annular gap between the frame of the FyreBox and the slab edge.	None	-/240/240

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation	FRL
D1 power cable bundle and 1 D2 communication cable bundle on a steel cable tray	175 mm concrete floor slab	FyrePlug Pillows fitted into 300 mm wide × 1000 mm long aperture in the floor slab.	FyreFlex sealant applied in annular gap between services and pillows.	500 mm above slab	-/120/120
Bundle of 15 fire alarm cables				None	-/180/180
1 bundle of 20 CAT6 and 1 NBN cable				None	-/180/180
1 × DN 50 type B copper pipe	Minimum 120 mm concrete floor slab	FyrePlug pillows fitted into 300 mm wide × 300 mm long aperture in the floor slab	• FyreFlex sealant applied between the service and pillows to a nominal depth of 50 mm from the unexposed side. It finished on the unexposed side of the pillow with a 50 mm × 50 mm fillet. • Small beads of FyreFlex sealant were applied in the gaps between the pillow and the separating element.	Single layer of 450 mm from the pillows on the top side only	-/180/120
1 × DN 100 type B copper pipe				Single layer of 600 mm wrap from the pillows on the top side only	

The variations and outcome of this assessment are subject to the limitations and requirements described in section 2, 4 and 8 of this report. The results of this report are valid until 31 May 2025.

Contents

1. Introduction

This report documents the findings of the assessment undertaken to determine the likely fire resistance level (FRL) of the Trafalgar FyrePlug Pillows and Trafalgar TWrap or FyreWrap insulation system if tested in accordance with AS 1530.4:2014[1] and assessed in accordance with AS 4072.1:2005[2]. This assessment was carried out at the request of Trafalgar Group. The sponsor details are included in Table 3.

Table 3 Sponsor details

Sponsor	Address
Trafalgar Group	26A Ferndell Street South Granville NSW 2142, Australia

2. Framework for the assessment

An assessment is an opinion about the likely performance of a component or element of structure if it were subject to a standard fire test.

No specific framework, methodology, standard or guidance documents exist in Australia for doing these assessments. We have therefore followed the 'Guide to Undertaking Assessments In Lieu of Fire Tests' prepared by the Passive Fire Protection Federation (PFPF) in the UK[3].

This guide provides a framework to undertake assessments in the absence of specific fire test results. *'Some areas where assessments may be offered are:*

- *Where a modification is made to a construction which has already been tested*
- *Interpolation or extrapolation of results of a series of fire resistance tests, or utilisation of a series of fire test results to evaluate a range of variables in a construction design or a product*
- *Where, for various reasons – eg size or configuration – it is not possible to subject a construction or a product to a fire test.'*

Assessments will vary from relatively simple judgements on small changes to a product or construction through to detailed and often complex engineering assessments of large or sophisticated constructions.

2.1 Declaration

The guide to undertaking assessments in lieu of fire tests prepared by the PFPF in the UK requires a declaration from the client. By accepting our fee proposal dated 13 March 2020, Trafalgar Group confirmed 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.
- They agree to withdraw this assessment from circulation if the component or element of structure is 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.
- 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, they agree to ask the assessing authority to withdraw the assessment.

[1] AS 1530.4:2014: Standards Australia 2014, *Methods for fire tests on building materials, components and structures – Part 4: Fire-resistance tests for elements of construction*, AS 1530.4:2014, Standards Australia, NSW

[2] AS 4072.1:2005: Standards Australia 2005, *Components for the protection of openings in fire-resistant separating elements Service penetrations and control joints*, AS 4072.1:2005, Standards Australia, NSW

[3] Passive Fire Protection Forum (PFPF) 2019, *Guide to undertaking technical assessments of the fire performance of construction products based on fire test evidence*, Passive Fire Protection Forum (PFPF), UK

3. Description of the specimen and variations

The tested specimen comprises the Trafalgar FyrePlug pillow penetration systems and Trafalgar TWrap insulation wrap system. These systems have been tested over a number of years in accordance with AS 1530.4.

The FyrePlug pillows come in three sizes as illustrated in Table 4 – consisting of fabric bags filled with granular mineral wool material and the pillow lengths have been reduced over the years from 300 mm to 250 mm nominally. Trafalgar Group, previously trading as Fire Containment, purchased the FyrePlug pillow IP from Wormald. Trafalgar Group has advised that the formulation of the granular mineral wool infill material in the FyrePlug pillow remained the same over the years and the previous test data on the pillows would therefore have not varied and are valid.

TWrap is a 25 mm thick foil encapsulated ceramic fibre blanket for applying over services and penetrations in building elements (walls and floors) to provide additional insulation performance. The TWrap is supplied in rolls of 300 mm and 600 mm wide.

FyreWrap is a 38 mm thick foil encapsulated ceramic fibre blanket used to enhance the insulation performance of service penetrations.

3.1 System description

The FyrePlug pillows is used as a substitute fire barrier over a predetermined opening in a wall or floor to facilitate existing or new services passing through the separating building element while maintaining the required fire resistance level or FRL of the separating building element and the service penetration systems if tested in accordance with AS 1530.4:2014 and in compliance with AS 4072.1:2005. The general arrangement of Trafalgar FyrePlug pillows in walls and floors is detailed in Figure 1 and Figure 2. Table 4 and Table 5 show the dimension of the pillows and the recommended packing density of each size, respectively.

Table 4 Dimensions of each pillow size

Pillow size	Width (mm)	Length (mm)	Height (mm)
Small	100	250	40
Medium	200	250	40
Large	300	250	40

Table 5 Packing density

Size of pillows	Required packing density
Small	600 per square metre
Medium	190 per square metre
Large	125 per square metre

The TWrap or FyreWrap insulation blankets are applied over pipe and cable services penetrations in order to achieve the required insulation performance of the separating wall or floor element or maintain the FRL of the wall or floor systems.

3.2 Referenced test data

The assessment of the variation to the tested system and the determination of the likely performance is based on the results of the fire tests documented in the reports summarised in Table 6 details the tested systems that are described in Appendix A.

Table 6 Referenced test data

Report number	Test sponsor	Test date	Testing authority
SI 1562	Fire Research Pty Ltd	23 April 1982	Department of Housing and Construction- Experimental Building Station (facility now known as CSIRO)
SI 1614	Fire Research Pty Ltd	4 August, 1982	Department of Housing and Construction- Experimental Building Station (facility now known as CSIRO)
NI 0387-2	Masterbilt Industries	4 March 1987	Fire Research Laboratories
NI 4189	Wormald International	16 November 1989	Fire Research Laboratories
NI 0790	Wormald International, Boral Australian Gypsum and CSR	18 April1990	Fire Research Laboratories
EP 6372	Fire Containment Pty Ltd	3 July 2018	BRANZ
FP 11935-001	Fire Containment Pty Ltd	14 August 2019	BRANZ
FRT180323.3	Trafalgar Group	29 November 2019	Warringtonfire Australia
FRT190292.4	Trafalgar Group	16 January 2020	Warringtonfire Australia
FRT190298.1	Trafalgar Group	23 January 2020	Warringtonfire Australia
FRT200257	Trafalgar Group	2 October 2020	Warringtonfire Australia

3.3 Variations to tested systems

An identical system has not been subject to a standard fire test. We have therefore assessed the systems using baseline test information for similar systems. The variations to the tested systems together with the referenced baseline standard fire tests are described in Table 7 and Table 8.

Table 7 Variations to tested systems incorporating Trafalgar FyrePlug pillows and TWrap or FyreWrap insulation

Reference test	Description	Variations	Assessed FRL
FP 11935-001	In 11935- 001, the tested separating element was 116 mm steel stud plasterboard lined wall with 550 mm × 550 mm aperture filled with FyrePlug pillows as fire resistant barrier. Specimen 4 consisted of 300 mm wide ×47 mm deep cable tray with Appendix D1 power cables through FyrePlug pillows with FyreFlex sealant, and 300 mm lengths TWrap insulation (with 75 mm overlap) over cable tray and cables on either side of wall surface. Tray supported at 350 mm either side. The specimen achieved and FRL of -/90/120	• Re-arrangement of pillow stacking without pillows orientated vertically over those orientated horizontally forming a tee to provide additional 1 minute of integrity performance for FRL - /120/120. • Variation of separating wall to concrete or masonry wall of minimum thickness of 120 mm.	-/120/120
	In 11935-001, the tested separating element was 116 mm steel stud plasterboard lined wall with 550 mm × 550 mm aperture filled with FyrePlug pillows as fire resistant barrier. Specimen 5 consisted of 100 mm OD copper pipe with 1.67 mm wall thickness through FyrePlug pillows with FyreFlex sealant around pipe circumference, and 300 mm lengths TWrap insulation (with 75 mm overlap) on either side of wall surface. Pipe supported at 600 mm on unexposed side. The system performed up to 180 minutes integrity and insulation	• The results would apply to the same sealing system protecting copper, brass or ferrous metal pipes up to a maximum 101.6 mm OD having wall thicknesses equal or greater than those listed in Table 10.12.3.1 of AS 1530.4:2014. • Variation of separating wall to concrete or masonry 120 mm or thicker with minimum 2 hr fire rating.	• -/120/120 in 120 mm thick concrete or masonry wall • -/180/180 in 150 mm min. thickness concrete separating wall • Plasterboard wall system with an established FRL of -/180/180
	In 11935-001, the tested separating element was 116 mm steel stud plasterboard lined wall with 550 mm × 550 mm aperture	• Variation of separating wall to concrete or masonry 120 mm or thicker with minimum 2 hr fire rating. • Variation of separating wall to concrete or masonry for 150 mm or thicker with minimum 3 hour rating.	• -/120/120 in minimum 120 mm thick concrete/ masonry wall • -/180/120 in minimum 150 mm thick concrete/ masonry wall

Reference test	Description	Variations	Assessed FRL
	filled with FyrePlug pillows as fire resistant barrier. Specimen 6 consisted of a bundle of 10 TPS PVC insulated cables laid (at lower edge of aperture) on pre-packed FyrePlug pillows and the aperture filled with FyrePlug pillows packed above cable bundles. FyreFlex sealant applied with fillet around interface on each side to the cable bundle and FyrePlug pillows. The system maintained the integrity and insulation performance for 180 minutes and 120 minutes, respectively.		
	In 11935-001, the tested separating element was 116 mm steel stud plasterboard lined wall with 550 mm × 550 mm aperture filled with FyrePlug pillows as fire resistant barrier. Specimen 7 consisted of a bundle of 20 CAT6 PVC insulated data cables laid on pre-packed FyrePlug pillows and the aperture filled with FyrePlug pillows packed above cable bundle. FyreFlex sealant applied with fillet around interface on each side to the cable bundle and FyrePlug pillows. The system maintained the integrity and insulation performance for 180 minutes and 120 minutes, respectively.	• Variation of separating wall to concrete or masonry 120 mm or thicker with minimum 2 hr fire rating.	• -/120/120 in minimum 120 mm thick concrete/ masonry wall • -/180/120 in minimum 150 mm thick concrete/ masonry wall
FRT180323.3	The Speedpanel separating wall element failed insulation along the C-track due direct conduction in the C track along the joint. Accordingly, an FRL of -/120/30 was attributed.	• Install one layer of 13 mm fire rated plasterboard, 100 mm wide straps covering flange of the C-track.to maintain the insulation at the C track.	-/120/120
	A1 is a DN 100 type B copper pipe passing through system A penetration comprising a 350 mm wide × 450 mm deep aperture filled with Trafalgar FyrePlug pillows with FyreFlex sealant around pipe circumference, and 300 mm lengths TWrap insulation (with 75 mm overlap) on either side of wall surface. The system achieved an FRL of -/120/30.	• Extend TWrap insulation to 900 mm total lengths, add an additional layer of TWrap over the first 300 mm on each side to reduce the interface temperatures and to achieve 120 minutes in insulation. • Variation of separating wall to 75 mm Hebel wall	-/120/120 with Speedpanel wall -/90/90 with 75 mm Hebel AAC wall (with pipe wrapped with TWrap)
	In FRT180323.3, the tested separating element was a 78 mm thick Speedpanel wall system A2 consists of a bundle of 5 × 2.5 mm² TPC power cables and 5 × CAT 6 data cables through Trafalgar FyrePlug pillows and with FyreFlex sealant. The system achieved an FRL of -/120/120	Variation of separating wall to 75 mm Hebel AAC with reduced FRL -/90/90	-/120/120 with Speedpanel wall -/90/90 with Hebel AAC wall

Reference test	Description	Variations	Assessed FRL
	In FRT180323.3, system A3 consists of 3C+E 185 mm^2 power cable, 4 Nos of 3C+E 16 mm^2 power cable, Ø25 mm PVC conduit with fibre optic cable and cable tray through Trafalgar FyrePlug pillows and with FyrePEX sealant applied between pillows and PVC conduit with optic fibre. The interface between pillows and the services were sealed with FyreFlex sealant on both sides. The system achieved an FRL of -/120/60	Variation of separating wall to 75 mm Hebel AAC with reduced FRL of -/90/60	-/120/60 with Speedpanel wall or -/90/60 with Hebel AAC wall
FRT190292.2	In FRT190292.2, the tested separating element was 175 mm concrete floor slab. System I2 consists of one D1 power cable bundle and 1 D2 communication cable bundle attached on a steel cable tray and insulated for 300 mm length on the unexposed side above the slab. The system maintained the integrity and insulation performance for 120 minutes. The FRL was derated as the specimen was part of a multiple penetration system that achieved an FRL of -/120/90.	Assessed FRL by isolating test that failed early in the multiple penetrations system.	-/120/120
	In FRT190292.2 system I3 consists of one bundle of 15 fire alarm cables with FyreFlex sealant in annular gap.	Assessed to revise FRL by isolating specimen I2	-/180/180
	In FRT190292.2 system I4 consists of one bundle of 20 CAT 6 and 1 NBN cable protected by FyreFlex sealant	Assessed to revised FRL by isolating specimen I2	-/180/180
NI 0790	In NI 0790, the tested separating element was 95 mm 2 hr rated plasterboard lined steel stud shaft wall system. Specimen E consists of appendix D2 bundle of telecom cables in a 190 mm steel cable tray. -/120/90 based on performance of 127 minutes with no integrity failure and 92 minutes insulation	Provide TWrap insulation to improve on insulation performance. Other services previously tested in plasterboard and concrete wall systems can be installed in the 2 hour shaft wall system that is 95 mm thick an consists of 25 mm shaftliner from one side and two layers of 16 mm fire rated plasterboard on the other.	-/120/120
SI 1562	In SI 1562, the tested separating element was a 230 mm thick brick wall a 1810 mm long × 440 mm high opening. The aperture was packed and filled with fire rated Fire Research pillows. FRL achieved was an FRL of -/240/240	Data used for guidance to ascertain the performance of the Pillows in larger apertures. Aperture may be up to 1300 mm wide × 550 mm high in concrete or masonry walls equal or thicker than 120 mm.	-/180/180

Reference test	Description	Variations	Assessed FRL
		Applicability of FyrePlug Pillows in apertures within concrete or masonry wall systems rated up to FRL -/180/180.	
SI 1614	In SI 1614, the tested separating element was 150 mm thick reinforced 3 hr fire rated concrete floor with 1000 mm long × 700 mm wide opening system 1. The opening in the floor slab was 1,000 mm long × 700 mm wide. The perimeter along the long slab edges were reinforced with 45 mm × 25 mm × 1.6 mm steel angles and the narrow sides were fitted with 45 mm square × 1.2 mm plate steel RHS forming mullion supports which act as joints between side by side slots forming a continuous length of multiple slots 700 mm wide along the floor slab as required. The opening was packed with fire rated pillows. As the pillows were limited to installations in 200 mm maximum slot widths to ensure the pillows do not fall off, the 700 mm wide slot was divided into small modular frames of 200 mm maximum width using 25 mm square × 1.2 mm steel tube dividers secured to the concrete on the unexposed side. The services passing through the opening and the pillows consisted of two packs of cables each with a group bundle consisting of 4 × Ø 25 mm Pyrotenax metal sheathed power supply cables. One bundle was fitted with steel mesh sleeve. -/180/120 for pillows only. -/180/30 for cables without sleeve Performance of the cable with sleeve was 182 minutes without failure in integrity or insulation but the FRL would be limited to -/180/120	No variation except that services protected by pillows in a three hr rated concreted floor system would have the FRL limited to maximum of -/180/120 when installed in this modular system	-/180/120

Table 8 Variations to other tested systems and incorporating Maxilite Board, FyreBox Mini and FyreBox Maxi, and TWrap insulation.

Reference test	Description	Variations	Assessed FRL
FP6372	In FP6372, the tested separating element was 75 mm thick Hebel PowerPanel wall. System 2b consists of a 50 mm OD × 1.2 mm copper pipe penetrated the Hebel wall and extended 500 mm into the furnace side with end capped and 500 mm from the wall on the unexposed side and open ended. Annular gap was filled with FyreFlex sealant to full depth finished with a 15 mm on each side. The pipe was wrapped for 300 mm on both sides with TWrap blanket insulation. FRL achieved was -/120/90.	Extend insulation with an extra 100 mm TWrap.	-/120/120
FP11935-001	In FP11935-001, the tested assembly was 116 mm thick steel stud frame wall lined with 2 layers of 13 mm USG Boral Firestop plasterboard on both sides. An aperture of 550 mm × 550 mm was formed in the wall and lined with a layer of 800 mm × 800 mm Maxilite Board overlapping the aperture on the unexposed side of the plasterboard wall for facilitating services passing through the wall. Service 1 comprised a 100 mm OD × 1.65 mm thick copper pipe inserted through the 60 mm thick Maxilite Board and clamped to an external frame on the unexposed side. FyreFlex sealant applied to the annular gap. Pipe was wrapped with TWrap insulation (nominal 75 mm overlap on each wrap) for 420 mm from the board on exposed side and 600 mm on unexposed side. FRL achieved was -/120/60.	Provide first 100 mm with 3 layers of TWrap, next 200 mm with 2 layers and next 300 mm single layer.	-/120/120
	In FP11935-001, the tested assembly was 116 mm thick steel stud frame wall lined with 2 layers of 13 mm USG Boral Firestop plasterboard on both sides. System 2 consists of 156 mm OD × 1.80 thick copper pipe inserted through the 60 mm thick Maxilite Board and clamped to an external frame on the unexposed side. FyreFlex sealant applied to the annular gap. Pipe was wrapped with TWrap insulation (nominal 75 mm overlap on each wrap) for 420 mm from the board on exposed side and 1,100 mm on unexposed side with the first 300 mm with two layers of TWrap. FRL achieved was -/120/90	Provide first 100 mm with 3 layers of TWrap, next 200 mm with 2 layers and next 800 mm single layer	-/120/120
	In FP11935-001, the tested assembly was 116 mm thick steel stud frame wall lined with 2 layers of 13 mm USG Boral Firestop plasterboard on both sides system 3 consists of 300 mm wide× 47 mm deep cable tray with Appendix D1 power cables through the lower section of the Maxilite Board. FyreFlex sealant applied into gap between Maxilite Board and cable tray and cables on both faces. The cables and the cable tray were wrapped with a single 300 mm long TWrap insulation wrap on both faces (with a nominal overlap of 75 mm). FRL achieved was -/120/120.	Allowable variation in wall system to a 120 mm thick concrete wall	-/120/120
FRT190292.4	In FRT190292.4, the separating element was 175 mm concrete slab. System E1 consists of D1 cables on a small steel cable tray with 450 mm TWrap on the unexposed side. FRL achieved was -/15/15.	Revised and assessed performance with isolation of surrounding failed test.	-/240/120

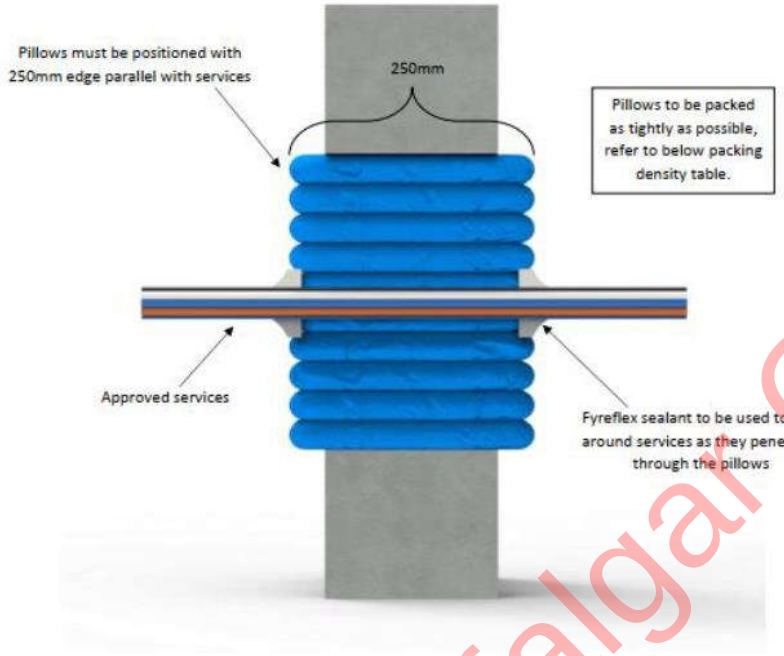

Figure 1 Proposed configuration of Trafalgar FyrePlug pillows in vertical walls

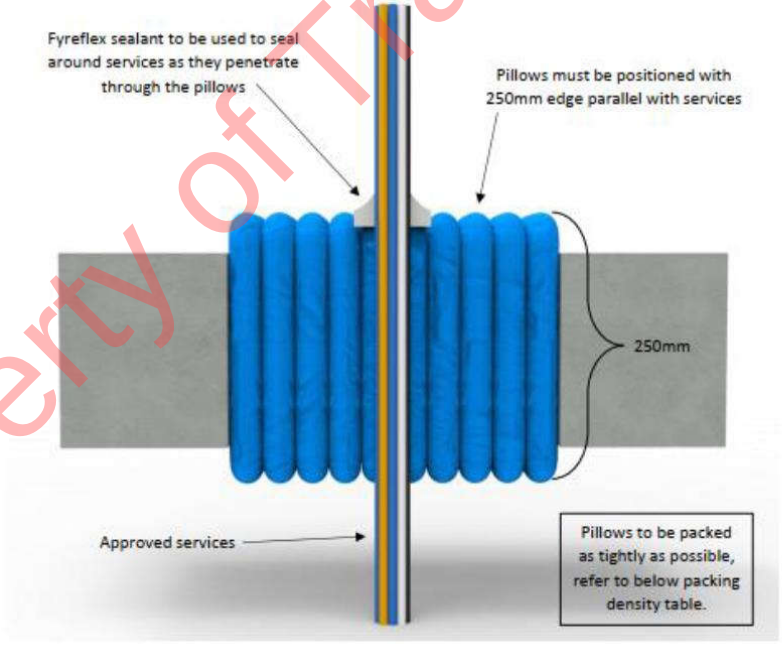

Figure 2 Proposed configuration of Trafalgar FyrePlug pillows in floors

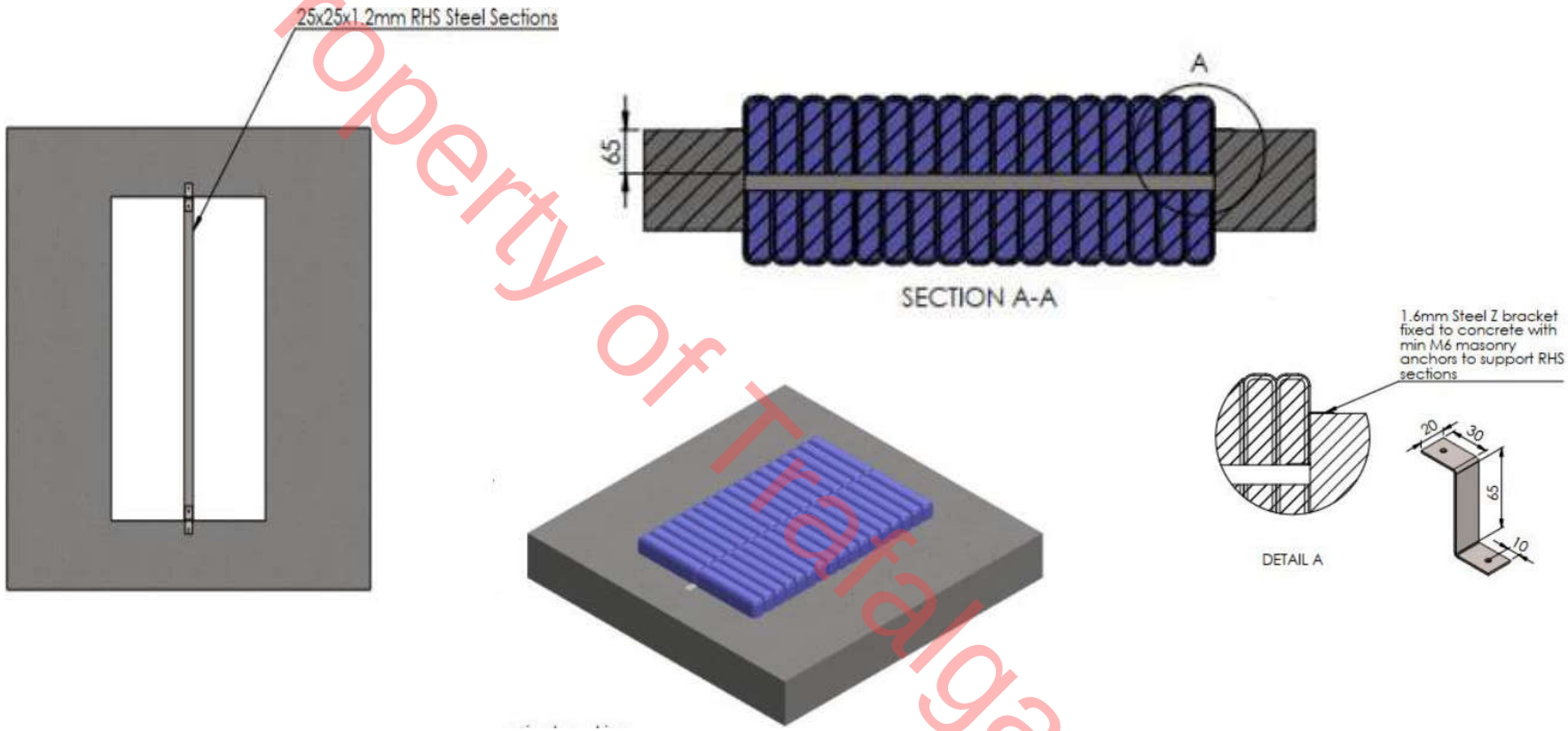

Figure 3 Proposed modular pillow detail

3.4 Purpose of the test

The purpose of the test in accordance with AS 1530.4:2014 is to determine the fire resistance performance of the Trafalgar FyrePlug Pillows and TWrap or FyreWrap insulation in sealing and protecting service penetrations in walls and floors, and to meet with AS 4072.1:2005. These requirements would likely become a compliance requirement in the National Construction Code in 2022 or NCC 2022.

AS 1530.4:2014 sets out the methods of testing to determine the fire resistance of elements of construction when subjected to standard fire exposure conditions,

AS 4072.1:2005 sets out the minimum requirements for the construction, installation and application of fire resistance tests to sealing systems around penetrations through building elements that are required to have a fire resistance level (FRL) or, if applicable, a resistance in the incipient spread of fire. The Standard is to be applied in conjunction with AS 1530.4:2014 which provides the applicable test methods.

4. Scope, objective and assumptions

- The scope of this report is limited to an assessment of the variations to the tested systems described in 1.1
- This report details the methods of construction, test conditions and assessed results that would have been expected if the specific elements of construction described here had been tested in accordance with AS 1530.4:2014 and AS 4072.1:2005.
- The results of this assessment are applicable to sealing systems for similar methods of constructions and building elements as tested in accordance with AS 1530.4:2014 and assessed in accordance with AS 4072.1:2005.
- This report is only valid for the assessed systems. Any changes with respect to size, construction details, loads, stresses, edge or end conditions, other than those identified in this report, may invalidate the findings of this assessment. If there are changes to the system, a reassessment will be needed to verify consistency with the assessment in this report.
- The data, methodologies, calculations and conclusions documented in this report specifically relate to the assessed system/s and must not be used for any other purpose.
- The drawings and information that forms the basis for this report is listed in 8.Appendix A
- This report has been prepared based on information provided by others. Warringtonfire has not verified the accuracy and/or completeness of that information and will not be responsible for any errors or omissions that may be incorporated into this report as a result.

5. Assessment of services in Trafalgar FyrePlug pillows in walls and floors

5.1 Background

Trafalgar Group has over the years conducted tests on sealing systems for service penetrations in building elements to determine their ability to maintain the required fire resistance levels of the penetrated element. The tests were conducted in accordance with AS1530.4 and to various versions of the test standard.

The National Construction Code (NCC) has informed that NCC 2022 would require all fire resistance tests to be in accordance with the current version of AS 1530.4, i.e AS 1530.4:2014 in turn references the requirement to comply with AS 4072.1:2005 with regards to service penetrations in building elements requiring an established FRL.

This assessment provides an overview of the test data from various fire resistance tests conducted over the years and determine if they are still relevant and accurate. The data is collated and compared with those from newly conducted tests in accordance with the current version of AS 1530.4 and AS 4072.1. Where the baseline data has not varied significantly, the relevant tests information will

be referenced to validate the variations against the newly tested systems.

5.2 Tested systems and proposed variations

The referenced tests provided by Trafalgar Group include sealing systems for service penetrations directly in building elements and services penetrations via a secondary fire - resistant barrier fitted into an aperture of appropriate dimensions to accommodate and to facilitate the sealing of the services passing through the aperture and building element. The barrier consists of one of the following:

- Maxilite Board,
- FyreBox Mini, FyreBox Maxi, and
- FyrePlug pillows.

The assessment on services penetrations through the building element directly will be only for metal pipes and electrical and communication cables, including cable trays. The assessment includes variations to the tested specimen with the use of TWrap or FyreWrap insulation blankets to provide the required insulation performance for maintaining the required FRL of the building element.

Other variations to be assessed are the replacement of the separating element with other building elements of equivalent fire resistance levels.

5.3 Methodology

The approach and method of assessment used for this assessment is summarised in Table 9.

Table 9 Method of assessment

Assessment method	
Level of complexity	Intermediate assessment
Type of assessment	Qualitative and Quantitative – interpolation

5.4 Assessment 1 – Services penetrations in Trafalgar FyrePlug pillows in vertical walls

5.4.1 Services penetrating Trafalgar FyrePlug pillows in plasterboard wall systems

In the referenced test report FP11935-001, a 2200 mm × 1000 mm × 116 mm thick steel stud lined with two layers of 13 mm thick fire rated plasterboard was tested. The wall consisted of two 550 mm × 550 mm apertures and fitted with seven pipe and cable penetrations. One of the apertures was protected with 800 mm × 800 mm Maxilite board which included one cable tray and two copper pipe penetrations. The other aperture was filled with a FyrePlug pillows and included one cable tray, one copper pipe, one TPS cable bundle and one CAT6 cable bundle penetrations.

Services in Maxilite board

Test FP11935 Penetration No.1-

The service is a 100 mm dia. copper pipe insulated with TWrap for 420 mm on the exposed side and 600 mm on the unexposed side. The annular gap at the penetration was protected with FyreFlex sealant. The specimen performed to 180 minutes in integrity and 88 minutes in insulation.

From the test temperature vs time graphs, it is evident that the early failure in insulation was only at the interface on the Maxilite Board at 25 mm from the TWrap. All temperatures recorded elsewhere did not fail insulation for at least 120 minutes. It is likely that the excessive rise in temperature at the interface would be due to inability of the sealant in the annular gap around the pipe penetration to limit the heat transfer rate.

There temperature on the TWrap was below the limit for insulation failure for more than 120 minutes.

Penetration No. 3 which incorporated electrical cables performed to an FRL of -/120/120 which indicates that the Maxilite board on its own without penetrations would have performed to at least the same or higher FRL.

Test FP11935 Penetration No. 2-

The service is a 156 mm dia. copper pipe insulated with TWrap for 420 mm on the exposed side and 1100 mm on the unexposed side and with a double layer of TWrap for the first 300 mm. The specimen failed in insulation in less than 120 minutes only on the Maxilite Board at the interface. The temperature on the Maxilite Board at the interface failed insulation at 104 minutes compared to 88 minutes for penetration No.1, an improvement of 16 minutes. The temperatures recorded elsewhere did not exceed the limit for failure for more than 120 minutes. The temperatures were generally lower than those for penetration No.1.

It appears from reviewing the test temperature graphs, that the insulation failure was due to insufficient insulation performance at the annular gap causing a higher rate of heat transfer from the penetration outwards along the unexposed surface of the board. Since the temperature on the TWrap at the interface was within the limit for failure for more than 120 minutes, it is considered that the interface temperature would likely be delayed in rising to the limit by at least 16 minutes if an additional layer of TWrap were added at the interface.

As there was no insulation failure on the TWrap for more than 120 minutes, the required width of the third layer would be minimal or a conservative 100 mm.

Based on the above discussion for penetration no.2, it is considered that if the copper pipe in penetration no.1 were to be insulated with 2 layers of TWrap for the first 300 mm and with a third 100 mm layer added at the interface, the specimen would likely have maintained insulation performance for at least 16 minutes.

The temperature on the bare pipe at the end of insulation, 600 mm from the penetration no. 1 was only about 150°C above ambient after 120 minutes whilst corresponding temperature for penetration no. 2 at 1100 mm away from the penetration was about 130°C. It is reasonable to assume that the lower temperature in the pipe for the latter would have been mainly due to the extra 500 mm length of single wrapped pipe.

The TWrap insulation requirements to be applied to both sides for fire exposure from either side are summarised as follow:

Penetration no.1- first 100 mm with 3 layers, next 200 mm with 2 layers and next 300 mm single layer.

Penetration no.2- first 100 mm with 3 layers, next 200 mm with 2 layers and next 800 mm single layer.

The results from the test for penetrations no.1 & 2 for the 100 mm and 150 mm diameter copper pipes will apply to brass, copper and ferrous metal pipes having wall thicknesses equal or greater than those listed in Table 10.12.3.1 of AS 1530.4:2014 for all pipe sizes up to and including 150 mm OD.

Test FP11935 Penetration No.3 – Cable tray and power cables as per Appendix D1

The service in penetration no.3 was a cable tray with power cables arranged in accordance with Appendix D1 in AS 1530.4:2014 and was wrapped with TWrap for 300 mm on both sides of the board.

The specimen performed to an FRL of -/120/120.

It is also noted that the test continued with “over burn” or beyond the rated FRL of the separating wall element which is -/120/120. From the temperature graphs, it indicated that even though the cables and cable tray, maintained integrity for at least 180 minutes, and failed insulation before 180 minutes, the Maxilite Board continued to maintain integrity as well as insulation for at least 180 minutes.

The Maxilite Board is therefore suitable as a fire resistance barrier installed in an aperture required to maintain an FRL of up to -/180/180.

Performance of penetrations in the board installed in a wall system with an FRL higher than -/120/120 will require further test data in accordance with AS 1530.4:2014 ad AS 4072.1:2005.

Services in Trafalgar FyrePlug pillows

Test FP11935-01 Penetration nos. 4, 5, 6 and 7

In test report FP11935-01, an aperture 500 mm × 500 mm was formed in a 116 mm thick plasterboard lined steel stud wall system. The aperture was packed with FyrePlug Pillows. There were four service penetrations, nos. 4, 5, 6 and 7, through the aperture and FyrePlug Pillows.

Service penetration no. 4 consisted of an Appendix D1 power cables on a steel cable tray and was insulated with TWrap for a length of 300 mm from the wall surface on each side. The system performed to an FRL of -/90/120.

Looking at the temperature graphs and the performance of the FyrePlug Pillows at other penetrations, it appears that there was no integrity failure for 180 minutes of exposure. Additional information was provided in the form of time sequential photographs from the archive of the test laboratory of the specimen from the start of test and up to integrity failure with the cotton pad test. It appears that there was a relatively large gap created by the placement of vertically orientated pillows onto horizontal pillows at the bottom corner of the aperture adjacent to the specimen. Hot gases were escaping via the gap opening and resulting in integrity failure just under 120 minutes.

The FyrePlug pillows in all other areas were neatly packed with minimal gaps. It is obvious that if the pillows were better packed without having vertically orientated Pillows placed over horizontally orientated Pillows, the specimen would have performed adequately in integrity for at least 180 minutes. It is therefore considered that if the FyrePlug pillows were packed tightly in one orientation only, the specimen penetration would have achieved an FRL of -/120/120 if testing in accordance with AS 1530.4:2014.

Service penetration no. 5 consisted of a Ø100 mm copper pipe insulated with TWrap for 600 mm from the wall surface on the unexposed side and 300 mm on the exposed side. The specimen maintained the integrity and insulation performance for 180 minutes. However, FRL was derated to FRL of -/120/120 to match the established FRL of the separating element. The achieved results of the sealing system are expected to be maintained when protecting copper, brass or ferrous metal pipes up to a maximum 101.6 mm OD having wall thicknesses equal or greater than those listed in Table 10.12.3.1 of AS 1530.4:2014.

Service penetration nos.6 and 7 consisted of bundle of TPS cables and a bundle of CAT6 data cables respectively. Both services maintained the integrity performance for the whole 180 minutes duration of the test. On the other hand, the insulation performance was compromised at 159 minutes for the TPS cable bundle and 173 minutes for the CAT6 data cable bundle. Ultimately, the FRL was derated to an FRL of -/120/120 for both services to match with the established FRL of the separating element.

5.4.2 Services penetrating Trafalgar FyrePlug pillow installed in Speedpanel wall

In test report FRT180323, the test assembly consisted of a 78 mm thick Speedpanel wall system penetrated by 18 services across 15 systems.

An aperture of 350 mm wide × 450 mm high was made in the Speedpanel wall system. The opening was packed all around the penetrating services over the full depth of the wall. There were three penetration services installed in system A.

In the fire test, system A failed insulation due to the location of a thermocouple placed on the C-track of the main separating Speedpanel wall system which had been assumed to have an established FRL of -/120/120. As noted from the test photographs, the aperture for system A was located close to the C-track of the main Speedpanel separating wall. The temperature graphs indicated a localised hot spot due to the rise in temperature in the C-track. The temperatures recorded further away from the C-track on the FyrePlug pillow and on the Speedpanel wall surface (from data collected for other penetration systems on the Speedpanel wall) were below the limits for insulation failure for the full duration of the fire test. It is therefore reasonable to consider that if the main wall system were to perform to its true FRL, ie., the temperature on the unexposed side of the entire Speedpanel wall system not exceeding the limit for maximum temperature rise, the fire performance of the penetration system services will be those recorded for the individual service penetration only.

It is proposed that the wall system be optionally replaced with an equivalent thickness (75 mm) Hebel AAC wall with a lower established FRL of -/90/90. It is considered that the systems would perform to the lower required FRL without any adverse effects if the fire stopping systems were to be applied.

Test FRT190298 Penetration B

In test report FRT190298.1, penetration system B, a 300 mm square and 60 mm thick Maxilite Board was installed over a circular hole in a Speedpanel wall system. A similar sized hole was centrally cut into the Board to align with the hole in the Speedpanel. The purpose of the Maxilite Board is to facilitate the passage of a Ø100 mm uPVC pipe and to provide a uniform flat surface for mounting a fire collar for protecting the circular opening.

The system performed to the required FRL of -/120/120.

Test FRT180323 Penetration I

In test report 180323.3, penetration system I, a FyreBox Maxi 650 with dimensions of 650 mm wide × 115 mm high × 250 mm deep was fitted on both the exposed and unexposed side into an aperture of 670 mm × 140 mm in a Speedpanel wall system. The intumescent strips which were friction fitted into the Boxes were slit and notched to accommodate two services penetrations.

The services were I1, a Ø40 mm CPVC sprinkler pipe and I2, a Ø60 mm CPVC sprinkler pipe.

I1 performed to 121 minutes without failure in integrity and 24 minutes in insultation and I2 to 121 performed to 121 minutes without failure in both integrity and insulation. However, both FyreBox Maxis, being part of the penetration system performed only to 36 minutes in insulation with no integrity failure for 121 minutes.

Looking at the test data, it is evident that the intumescent did not adequately close off the penetration on the exposed side when the pipe material melted in I1. The intumescent in I2, a larger pipe, did close off evenly and did not allow the temperature on the intumescent in the unexposed FyreBox Maxi to rise above the limit for failure.

The early failure in insulation in the FyreBox Maxi on the unexposed side was due clearly due to heat conduction long the steel frame surrounding the FyreBox Maxi and at the interface 25 mm from the protruding metal angles of the frame (direct radiant heat from the heater metal angles). The fact that the temperatures recorded at the interface slightly further away did not fail insulation for 121 minutes indicates that the main issue is heat radiating from the metal fame.

As the steel frame is of relatively thin metal sheet (small sectional area) around the perimeter of the aperture, the heat flow rate is limited by the total section area. If the surface of the upstand metal frame were to be clad with TWrap insulation blanket, the temperature on the outer surface of the blanket would likely be below the lit for insulation failure for 120 minutes of exposure. This is due to the insulation properties of the blanket, the relatively low heat flow rate along material thickness at the perimeter and the larger surface area of the blanket surface limiting the temperature rise (heat sink effect). It is proposed that the outer surface of the box frame be wrapped with TWrap insulation blanket and extending or overlapping at least 25 mm over the wall panel surface along the perimeter of the aperture. The insulation shall be adequately tied onto the FyreBox frame.

If the FyreBox maxi unit were to be insulated with TWrap blanket as described above, the FyreBox will likely maintain insulation performance for at least 120 minutes if tested in accordance with AS 1530.4:2014. The results I2 can be revised to perform to an FRL of -/120/120.

It is proposed that the wall system be optionally replaced with an equivalent thickness (75 mm) Hebel AAC wall with a lower established FRL of -/90/90. It is considered that the systems would perform to the lower required FRL without any adverse effects if the fire stopping systems were to be applied.

Test FRT180323 Penetration service A1

Penetration A1 consisted of a DN100 or 100 mm OD type B copper pipe insulated with 300 mm length TWrap from the wall on both sides. The sealing system at the service penetration performed with no failure for 121 minutes in integrity and to 75 minutes in insulation. The failure in insulation occurred firstly at the service after the TWrap at 75 minutes and later at the interface with the wall on the TWrap after 109 minutes. Using the same interpolation method for estimating the amount of insulation required from the previous discussion for test FP11935, it can be calculated that the additional insulation length required to attain a temperature at the service for 120 minutes exposure is 599 mm or 600 mm to the nearest wrap width. There is also a requirement to provide sufficient

insulation at the interface by adding conservatively an additional 300 mm wide TWrap at the interface in order to maintain a temperature below the maximum temperature limit for the full 120 minutes duration. In summary, the pipe shall be insulated with two layers of TWrap, first layer for 600 mm and second layer for the first 300 mm only.

Test FRT180323 Penetration service A2

Penetration A2 consisted of a bundle of TPS and CAT6 cable protected by FyreFlex sealants and the FyrePlug Pillows. The service performed to 121 minutes without failure in both integrity and insulation. The penetration service A2 is therefore assessed positively to an FRL of -/120/120 in accordance with AS 1530.4:2014.

Test FRT180323 Penetration service A3

Penetration A3 consisted of a series of power cables on a steel cable tray to Appendix D1. The service performed to 121 minutes without integrity failure and 87 minutes in insulation. It is noted that the service failed in insulation at the service only. It can be interpolated and calculated similar to in service A1 that the insulation length required to achieve the additional insulation to 120 minutes would be to provide TWrap over the cables tray and cables for at least 600 mm. The penetration service is assessed with an FRL of -/120/120.

5.4.3 Services penetrating a shaftwall system

Test NI 0790 Penetration

Penetration E in test NI 0790 consisted of a D2 bunch of telecom cables in a 190 mm steel cable tray protected by FyrePlug Pillows and FyreFlex sealants through a 400 mm wide × 300 mm high opening in a 95 mm plasterboard lined steel stud shaft wall system. The test was conducted in accordance with AS 1530.4:1990 which differs from the current 2014 version. The criteria for failure in integrity and insulation failure are almost the same except for the application of cotton pads in detecting integrity failure.

The data from test NI 0790 indicates that cotton pads were applied for checking possible failure during the test. The ongoing tests on service penetrations involving the use of FyrePlug Pillows over the years and to various versions of AS 1530.4, including the current version, has consistently produced positive results confirming the same performance in integrity and insulation. The results from the test conducted in NI 0790 would be considered as being accurate until confirmed otherwise by a repeat test in accordance with the current AS 1530.4:2014.

The service in NI 0790 performed to 127 minutes without integrity failure and 92 minutes in insulation. Comparing the performance of similar cable penetration I2 in test FRT190292, where TWrap is applied to insulate for a calculated length from the separating floor element, it can be similarly interpolated to provide TWrap insulation to achieve an improved insulation performance of at least 120 minutes.

In order to improve on the insulation performance from 92 minute to 120, the estimated TWrap length required for the service is approximately 300 mm. It is therefore conservatively considered that if the service were to be wrapped with 300 mm length of TWrap, the performance of the service penetration with the D2 cables and cable tray will likely achieve an FRL of -/120/120 if tested in accordance with AS 1530.4:2014.

Various metal and cable services

It is proposed to extend the performance achieved of services tested in plasterboard walls to 95 mm thick shaft wall system. After review of test data in NI 0790, it was observed that the thermocouples placed on the pillow did not exceed the maximum temperature rise threshold throughout the test duration except for thermocouple C5. Thermocouple C5 was placed 25 mm above the telecom cable penetrations. Further review of the time vs temperature curve showed that insulation failure occurred at 112 minutes. This insulation failure is a local weakness caused by the type of penetration in the Trafalgar FyrePlug pillow. The additional insulation wrapping proposed to be installed around the cable tray and cable services involves applying FyreFlex sealant in a fillet arrangement to seal the wrap back to the pillow. This arrangement is expected to push the thermocouple further up closer to thermocouple C4 where the maximum temperature recorded at 120 minutes did not exceed 90°C.

Based on the above discussion, it is evident that the interface between the shaftwall system and Trafalgar FyrePlug pillow was maintained throughout the 120 minutes duration of the test. Accordingly, it is reasonable to consider that if the same service was to be installed in a 2 hour plasterboard or concrete wall, the integrity and insulation performances will be maintained for 120 minutes. Alternatively, the services tested in concrete and plasterboard wall system can be installed in the 95 mm thick Shaft wall system without any impact on the established FRL of the services in the Trafalgar FyrePlug pillow.

5.4.4 Services penetrating Trafalgar FyrePlug pillow in concrete or masonry walls

In accordance with the provisions in AS 1530.4:2014, the results for the test with a plasterboard lined frame wall system would be applicable for similar penetration and sealing systems installed in a concrete or masonry wall of the same or greater thickness. The results from the penetration in the Maxilite board therefore would be applicable if installed in an equivalent 120 mm thick concrete or masonry separating wall element. With reference to test FP11935-001, the test continued for 3 hours in a wall rated to 2 hours and thermocouple data from the system maintained an integrity and insulation performance for up to 180 minutes. DN100 copper pipe did not fail integrity and insulation for 180 minutes. Other cable penetrations maintained integrity for 180 minutes and insulation for 120 minutes. Accordingly, it is reasonable to consider that if the proposed systems were to be installed into a concrete/masonry wall with an established FRL of -/180/180, both cable penetrations would be expected to achieve an FRL of -/180/120 and DN100 copper pipe would be expected to achieve an FRL of -/180/180.

5.4.5 Services penetrating Trafalgar FyrePlug pillow in 75 mm thick Hebel wall

Test FP6372 Penetration 2b

Penetration 2b in test FP6372 consisted of a 50 mm OD × 1.2 mm thick copper pipe penetrating a 75 mm Hebel PowerPanel wall system protected by FyreFlex sealant in the annular gap to full depth and finished with a 15 mm fillet on each side. The pipe was wrapped with TWrap for 300 mm on either side of the wall. The service performed to at least 125 minutes in integrity and 117 minutes in insulation. The assigned FRL was -/120/90. As the penetration fell short by just 3 minutes in insulation, the pipe could be insulation with an additional 100 mm to ensure than the insulation performance can be revised to provide an FRL of -/120/120.

The Hebel AAC wall has a similar temperature profile when heated as it is of a lightweight cement base core mixture, like that of Speedpanel, except that it has a lower established FRL of -/90/90. The system as tested in FRT190298 maintained the required FRL of the separating element, Speedpanel. It is considered that the same service penetration and construction setup and fire stopping will adequately perform to the required lower FRL of the Hebel wall of FRL -/90/90 if tested in accordance with AS 1530.4:2014.

5.4.6 FyreBox Mini and FyreBox Maxi

The FyreBox is a steel framed box of relatively smaller dimensions fitted an opening in the separating building element with a required FRL to facilitate ease of passage of small building services such as pipes and cables services through an existing building element with a required FRL and maintaining the fire resistance levels of the particular element. Both the FyreBox Mini and FyreBox Maxi basically incorporate the same mode of protecting the services in adequately sealing the penetration with intumescent layers fitted over the entire internal boxed section within the steel frames. The Mini caters for smaller penetrating services whilst the Maxi, the larger services.

Test FRT180323 Penetration I

In test report 180323.3, penetration system I, a FyreBox Maxi 650 with dimensions of 650 mm wide × 115 mm high × 250 mm deep was fitted on both the exposed and unexposed side into an aperture of 670 mm × 140 mm in a Speedpanel wall system. The intumescent strips which were friction fitted into the Boxes were slit and notched to accommodate two services penetrations.

The services were I1, a Ø40 mm CPVC sprinkler pipe and I2, a Ø60 mm CPVC sprinkler pipe.

I1 performed to 121 minutes without failure in integrity and 24 minutes in insultation and I2 to 121 performed to 121 minutes without failure in both integrity and insulation. However, both FyreBox

Maxis, being part of the penetration system performed only to 36 minutes in insulation with no integrity failure for 121 minutes.

Looking at the test data, it is evident that the intumescent did not adequately close off the penetration on the exposed side when the pipe material melted in I1. The intumescent in I2, a larger pipe, did close off evenly and did not allow the temperature on the intumescent in the unexposed FyreBox Maxi to rise above the limit for failure.

The early failure in insulation in the FyreBox Maxi on the unexposed side was due clearly due to heat conduction long the steel frame surrounding the FyreBox Maxi and at the interface 25 mm from the protruding metal angles of the frame (direct radiant heat from the heater metal angles). The fact that the temperatures recorded at the interface slightly further away did not fail insulation for 121 minutes indicates that the main issue is heat radiating from the metal fame.

As the steel frame is of relatively thin metal sheet (small sectional area) around the perimeter of the aperture, the heat flow rate is limited by the total section area. If the surface of the upstand metal frame were to be clad with TWrap insulation blanket, the temperature on the outer surface of the blanket would likely be below the lit for insulation failure for 120 minutes of exposure. This is due to the insulation properties of the blanket, the relatively low heat flow rate along material thickness at the perimeter and the larger surface area of the blanket surface limiting the temperature rise (heat sink effect). It is proposed that the outer surface of the box frame be wrapped with TWrap insulation blanket and extending or overlapping at least 25 mm over the wall panel surface along the perimeter of the aperture. The insulation shall be adequately tied onto the FyreBox frame.

If the FyreBox Maxi unit were to be insulated with TWrap blanket as described above, the FyreBox will likely maintain insulation performance for at least 120 minutes if tested in accordance with AS 1530.4:2014. The results I2 can be revised to perform to an FRL of -/120/120.

5.5 Assessment 2 – Services penetrating Maxilite board, Fyrebox mini, Fyrebox maxi and Trafalgar FyrePlug pillows installed in floor systems

5.5.1 Maxilite Board

Test FRT190292 Penetration E1

E1 comprising D1 cables on a small steel cable tray with 450 mm TWrap on the unexposed side performed to 241 minutes without integrity failure and 154 minutes in insulation. It would have achieved an FRT of -/240/120 if tested separately in accordance with AS 1530.4:2014.

The specimen failed insulation mainly at the interface on the Maxilite Board and the service cable and on the service at the end of insulation. Attention is drawn to the failed E3 specimen which had improved insulation performance on the Board at the interface with an added patch board of 30 mm thick Maxilite board over the large 60 mm Maxilite board which covers the whole aperture for the E system. If specimen E1 were to have an added 30 mm thick Maxilite Board around the penetration it would have improved insultation for exposure to at least 240 minutes.

The other failure was at the cable at around 210 minutes. The cable was at 220°C above ambient at 240 minutes. Using the same interpolation and assumption as for penetration no.2 in test EP11935, it can be calculated that the E1 will require an additional 87 mm of extra length of insulation to maintain insulation performance on the cables for 240 minutes.

It is therefore considered conservatively that if the insulation TWrap were extended for another 100 mm (two 300 mm wide Twrap blankets installed with 50 mm overlap giving a total insulated length of 550 mm) plus an added 30 mm thick Maxilite board patch at the interface with the concrete slab, specimen E1 would likely achieve both integrity and insulation for 240 minutes if tested in accordance with AS 1530.4:2014.

Test FRT190292 Penetration F

Specimen F, consisting of a large pair coil, an orange power cable and a CAT 6 cable, performed up to 147 minutes of integrity with insulation failure in 115 minutes when the temperature at power cable service F11, 25 mm from the TWrap exceeded 180 K above ambient. The temperatures at the interface on the TWrap and on the separating element performed adequately within the maximum temperature limits for more than 120 minutes. Using double interpolation, it can be estimated that if the TWrap were to be extended by at 63 mm minimum. If the insulation TWrap were extended by 100 mm the service penetration will likely achieve an FRL of -/120/120 if tested in accordance with AS 1530.4:2014.

5.5.2 FyreBox Mini and FyreBox Maxi

Test FRT190292 Penetration I1

The penetration system I1 in test report FRT190292.4 consisted of six electrical cables penetrating through a FyreBox Mini 100 installed on the unexposed side of a concrete floor slab. The penetration I1 performed to 241 minutes with no integrity failure and 103 minutes in insulation.

From the temperature versus time graphs, the low insulation performance was due mainly to the rise in temperature of the uninsulated framing angles around the perimeter of the aperture in the floor on the unexposed side. Looking at the temperatures of recorded elsewhere which maintained insulation for at least 180 minutes, including at the interface on the surface of the FyrePlug Pillow adjacent to the uninsulated metal framing, the system insulation performance would have been improved to at least 180 minutes if the metal angles were insulated as discussed above for specimen I1 in test FRT180323. The metal frame around the aperture rising above the floor slab if insulated with a strip of TWrap all around cover the exposed metal angles and extending to the floor onto the slab surface, lapping by at least 25 mm.

It is also noted that the performance of I1 was affected by the failure of other services in the penetrating system I. It is considered that the failed system should be isolated from the other individual penetration service performance as the primary fire stopping element, the FyrePlug pillows, itself performed to at least 220 minutes in insulation and without integrity failure for 241 minutes. Penetration service I1 is therefore considered to likely perform to an FRL of -/240/180 if tested in accordance with AS 1530.4:2014.

Test FRT190292 Penetration H

Service penetration H in test report FRT190292.4 incorporated a drink python hose protected by a FyreBox Mini 150 installed in a Ø160 mm hole in the concrete floor slab on the unexposed side. The system performed to an FRL of -/240/240.

5.5.3 FyrePlug Pillows

Test FRT190292 Penetration system I

In test report FRT190292.4, an aperture of 300 mm wide × 1000 mm long was made in 175 mm concrete floor slab. The opening was packed all around the penetrating services with FyrePlug pillows. There were four electrical services penetrations installed in system I.

Test FRT190292 Penetration system I2

Penetration I2 consisted of one D1 power cable bundle and 1 D2 communication cable bundle attached on a steel cable tray and insulated for 300 mm length on the unexposed side above the slab. The service penetration performed to 147 minutes in integrity and 98 minutes in insulation. The services were wrapped with TWrap for 300 mm length. From the data, the insulation held the service from insulation failure for 98 minutes. If insulation performance were to be extended to 120 minutes, an additional length of TWrap to give the extra 22 minutes will be necessary. From the temperatures rise versus time, it is noted that the rate of rise of temperature rise increases toward the 98 minutes exposure compared with at the start of the test. The extra insulation length can be estimated as a ratio of 22/98 × 300 mm = 67 mm. As the rate of temperature rise was much higher towards the end of the exposure, a correction factor of 3.02/2.17 is applied, giving adjusted minimum extra length of 93 mm. If an extra 200 mm of insulation wrap were applied, the penetration service would have conservatively achieved an insulation performance for at least 120 minutes.

The penetration service perform would likely perform to an FRL of -/120/120 if the service were wrapped for a total length of 500 mm.

Test SI 1614 System 1

Test 1614 was conducted using modular framed slots which could be duplicated to infinite lengths to facilitate the protection building service risers penetration fire rated floor slabs. System 1 consisted of a 1000 mm long × 700 mm wide opening in a 150 mm thick reinforced concrete floor. The perimeter along the long slab edges were reinforced with 45 mm × 25 mm × 1.6 mm steel angles and the narrow sides were fitted with 45 mm square × 1.2 mm plate steel RHS forming mullion supports which act as joints between side by side slots forming a continuous length of multiple slots 700 mm wide along the floor slab as required.

The services were protected by FyrePlug Pillows placed in the retaining steel angles and mullions. It provides a means of adding a flexible solution for addition new services in existing installation by extending the modules to accommodate the additional services. The system performed to the 3 hr fire rating of the floor slab. It also provides indication of the limits of the Fyreplug in protecting 3 hr rated floor slab openings to a maximum of 120 minutes in insulation or a maximum FRL of -/180/120.

5.5.4 Aperture size in floors

It is proposed to install penetration system B with an FRL -/180/120 tested in FRT200257, in a bigger aperture size with dimension (300 mm wide × 1000 mm long). With reference to test FRT190292.4, penetration system I2 showed no signed of failure in integrity and insulation for 147 minutes and 98 minutes respectively. However, it was positively assessed to -/120/120 if the service was wrapped for a total length of 500 mm. Hence, the proposed penetration system would likely perform to an FRL of -/120/120.

Test FRT200257 penetration system B

In test report FRT200257, an aperture of 300 mm wide × 300 mm long was made in a 120 mm thick concrete floor slab. The opening was packed with FyrePlug pillows all around the penetrating services over the full depth of the floor.

Penetration system B consisted of two services, a DN 50 type B copper pipe insulated with 450 mm long TWrap from the pillows on the unexposed side above the slab and a DN 100 type B copper pipe insulated with 600 mm long TWrap from the pillows on the unexposed side above the slab. FyreFlex sealant was applied between the service and the pillows to a nominal depth of 50 mm from the unexposed side. It finished on the unexposed side of the pillows with a 50 mm × 50 mm fillet. Small beads of sealant were applied in the gaps between the pillow and the separating element. The service penetration performed to 180 minutes in integrity and 152 in insulation.

Test FRT190292 penetration system I2

Penetration system I2 was installed in 300 mm wide × 1000 mm long aperture size in 175 mm thick concrete floor slab with FyrePlug pillows packing around the penetrating services. The penetration system consisted of one D1 power cable bundle and a D2 communication cable bundle attached on the steel cable tray and insulated for 300 mm length. The service penetration performed 147 minutes in integrity and 98 minutes in insulation. However, the system was positively assessed to an FRL -/120/120 if the services were wrapped for a total length of 500 mm.

TWrap vs FyreWrap insulation wrap

FyreWrap is a 38 mm foil encapsulated wrapping system supplied by Unifrax with a density of 96 kg/m³. TWrap is also supplied by Unifrax with a 25 mm foil encapsulated wrap with the same infill material and a density of 128 kg/m³. The fire resistance performance of the FyreWrap was established in test FCO 3226c where the wrap was used in protecting duct subjected to internal fire conditions. Ultimately, it is considered that the reduction in density when compared to TWrap is compensated by the increased thickness. As both wraps are made from the same material, it is reasonable to consider that the insulation performance achieved in TWrap can be extended to cover the same services when protected with FyreWrap.

5.6 Conclusion

This assessment demonstrates that the service penetrations protected by the Trafalgar Group resistant barrier and sealing systems as summarised in Table 10 and Table 11 are expected to achieve the shown FRLs if they were tested in accordance with AS 1530.4:2014.

Table 10 Assessment outcome in vertical walls

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation-	FRL
Steel cable tray and Appendix D1 power cables	A 116 mm thick wall that consists of 64 mm steel stud lined with two layers of 13 mm fire rated plasterboard on each side or 120 mm concrete or masonry wall	60 mm Maxilite board in 800 mm × 800 mm aperture	FyreFlex Sealant in joint between plasterboard wall and board on both sides and finished with fillet, in annular gap around service penetration	300 mm single layer on both sides	-/120/120
100 mm O.D × 1.65 mm copper pipe				Insulation wrap arrangement to be revised to be three layers of wrap in the first 100 mm followed with two layers for the next 200 mm followed with single layer for the next 300 mm.	
156 mm O.D × 1.80 mm copper pipe				Insulation wrap arrangement to be revised to be three layers of wrap in the first 100 mm followed with two layers for the next 200 mm followed with single layer for the next 800 mm.	
Ø100 mm uPVC SC pipe	78 mm Speedpanel wall system or 75 mm AAC Hebel wall	60 mm thick Maxilite board	Fire collar fitted on pipe at penetration on both sides of wall. FyreFlex sealant applied in apertures	none	-/120/120 in Speedpanel wall

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation-	FRL
50 mm O.D × 1.2 mm copper pipe			Annular gap was filled with FyreFlex sealant to full depth finished with a 15 mm on each side.	Insulation wrap of 300 mm on fire side and 400 mm on the non-fire side	-/90/90 in 75 mm AAC Hebel wall
Ø60 mm CPVC sprinkler pipe	78 mm Speedpanel wall system	FyreBox Maxi 650 fitted into a 670 mm × 140 mm aperture in the wall	Intumescent strip fitted in the FyreBoxes. FyreFlex sealant applied in apertures	100 mm wide strip wrap to be tied over the upstand metal angles protruding from wall surface forming a shroud with 25 mm of blanket lapping over wall surface on each side	-/120/120
	75 mm AAC Hebel wall				-/90/90
Appendix D1 power cables on steel cable tray	A 116 mm thick wall that consists of 64 mm steel stud lined with two layers of 13 mm fire rated plasterboard on each side Or 120 mm thick concrete wall Or 95 mm thick plasterboard lined steel stud shaft wall with an established FRL of -/120/120	FyrePlug pillows fitted into a 550 mm × 550 mm aperture in the wall	FyreFlex sealant applied in the annular gap between service and FyrePlug Pillows and between cables, cable tray and the FyrePlug pillows	300 mm on each side	-/120/120
100 mm OD copper pipe, including copper, brass or steel pipes up to 100 mm dia. as per clause 10.12.3, AS 1530.4:2014.					
TPS cable bundle					
CAT6 data cables					
Appendix D2 bundle of telecom cables on a steel cable tray					

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation-	FRL
100 mm OD copper pipe, including copper, brass or steel pipes up to 100 mm dia. as per clause 10.12.3, AS 1530.4:2014.	Plasterboard wall construction having a pre-established FRL of -/180/180 or concrete/masonry wall of an established FRL of -/180/180			600 mm on both sides of the wall	-/180/180
TPS cable bundle				none	-/120/120
CAT6 data cables				none	-/120/120
DN100 or 100 mm OD Type B copper, copper pipe, including copper, brass or steel pipes up to 100 mm dia. as per clause 10.12.3, AS1530.4:2014.	78 mm Speedpanel wall or 75 mm Hebel AAC wall	FyrePlug Pillows fitted into 1000 mm wide × 300 mm high aperture in the wall	FyreFlex sealant applied in annular gap between service and pillows	First layer for 600 mm followed by a second layer for the first 300 mm only applied on both sides	-/120/120 for Speedpanel walls or -/90/90 for Hebel wall
Bundle of TPS and CAT6 cables				None	
Appendix D1 power cables on a steel cable tray				600 mm on each side	

Table 11 Assessment outcome in floor systems

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation	FRL
Small steel cable tray and D1 cables	175 mm concrete floor slab	60 mm Maxilite Board over 1000 mm × 300 mm aperture in floor slab	FyreFlex sealant applied in a fillet arrangement around penetration and cable tray and cables on both sides	300 mm plus 300 mm with 50 mm overlap or total of width of 550 mm	-/240/240
2 pair coils, 2 orange power cables and 2 CAT 6 cables	175 mm concrete floor slab	FyreBox Mini 100 in the slot opening in the concrete slab protected all around by FyrePlug pillows friction fitted between the frame of the FyreBox and the slab edge of the floor opening.	Intumescent strips placed in FyreBoxes. FyreFlex sealant applied between pillows and flanges of the boxes at the interface.	None	-/240/90
				Wrap length of 300 mm. Tie wrap onto the unprotected upstand metal angles all around and extending 25 mm over the top of the pillow.	-/240/180
Drink Python hose		FyreBox Mini 150 fitted into opening in the concrete floor slab	Intumescent strip in Fyreboxes., FyreFlex sealant applied along the annular gap between the frame of the FyreBox and the slab edge.	none	-/240/240

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation	FRL
D1 power cable bundle and 1 D2 communication cable bundle on a steel cable tray	175 mm concrete floor slab	FyrePlug Pillows fitted into 300 mm wide × 1000 mm long aperture in the floor slab.	FyreFlex sealant applied in annular gap between services and pillows.	500 mm above slab	-/120/120
Bundle of 15 fire alarm cables				none	-/180/180
1 bundle of 20 CAT6 and 1 NBN cable				none	-/180/180
1 × DN 50 type B copper pipe	Minimum 120 mm concrete floor slab	FyrePlug pillows fitted into 300 mm wide × 300 mm long aperture in the floor slab	• FyreFlex sealant applied between the service and pillows to a nominal depth of 50 mm from the unexposed side. It finished on the unexposed side of the pillow with a 50 mm × 50 mm fillet. • Small beads of FyreFlex sealant were applied in the gaps between the pillow and the separating element.	Single layer of 450 mm from the pillows on the top side only	-/180/120
1 × DN 100 type B copper pipe				Single layer of 600 mm wrap from the pillows on the top side only	
Small steel cable tray and D1 cables	175 mm concrete floor slab	60 mm Maxilite Board over 1000 mm × 300 mm aperture in floor slab	FyreFlex sealant applied in a fillet configuration around penetration and cable tray and cables on both sides	300 mm plus 300 mm with 50 mm overlap or total of width of 550 mm	-/240/240
2 pair coil + 2 orange power cable + 2 CAT6 cable			FyreFlex sealant applied in a fillet configuration around penetration and cables on both sides	400 mm above slab	-/120/120

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation	FRL
2 pair coils, 2 orange power cables and 2 CAT 6 cables	175 mm concrete floor slab	FyreBox Mini 100 in the slot opening in the concrete slab protected all around by FyrePlug pillows friction fitted between the frame of the FyreBox and the slab edge of the floor opening.	Intumescent strips placed in FyreBoxes. FyreFlex sealant applied between pillows and flanges of the boxes at the interface.	Tie wrap onto the unprotected upstand metal angles all around and extending 25 mm over the top of slab.	-/240/180
Drink Python hose		FyreBox Mini 150 fitted into opening in the concrete floor slab	Intumescent strip in Fyreboxes., FyreFlex sealant applied along the annular gap between the frame of the FyreBox and the slab edge.	None	-/240/240
D1 power cable bundle and 1 D2 communication cable bundle on a steel cable tray	175 mm concrete floor slab	FyrePlug Pillows fitted into 300 mm wide × 1000 mm long aperture in the floor slab.	FyreFlex sealant applied in annular gap between service and pillows.	500 mm above slab	-/120/120
Bundle of 15 fire alarm cables				none	-/180/180
1 bundle of 20 CAT6 and 1 NBN cable				none	-/180/180
1 × DN 50 type B copper pipe	Minimum 120 mm concrete floor slab	FyrePlug pillows fitted into 300 mm wide × 300 mm long aperture in the floor slab	• FyreFlex sealant applied between the service and pillows to a nominal depth of 50 mm from the	Single layer of 300 mm and a single layer of 150 mm, with a total height of 450 mm from the pillows	-/180/120

Service	Separating element system	Penetration fire barrier	Fire stopping details	TWrap or FyreWrap insulation	FRL
1 × DN 100 type B copper pipe			unexposed side. It finished on the unexposed side of the pillow with a 50 mm × 50 mm fillet. • Small beads of FyreFlex sealant were applied in the gaps between the pillow and the separating element.	Two single layers of 300 mm and a single layer of 150 mm, with a total height of 600 mm from the pillows	
1 × DN 100 type B copper pipe				Two single layers of 300 mm and a single layer of 150 mm, with a total height of 600 mm from the pillows	

6. Assessment of variation in Trafalgar FyrePlug pillow colour

6.1 Proposed variations

It is proposed to assess the expected performance of Trafalgar FyrePlug pillows in different colours.

6.2 Methodology

The approach and method of assessment used for this assessment is summarised in Table 12.

Table 12 Method of assessment

Assessment method	
Level of complexity	Simple assessment
Type of assessment	Qualitative

6.3 Assessment

It is proposed to extend the achieved fire resistance performance of the Trafalgar FyrePlug pillows to cover different colours. It is understood that the variation in colour is only due to the difference in pigment in the pillow's fire retardant fabric. Moreover, Trafalgar group has confirmed that pillows of different colours are made of the same material and filled with the same quantity and material of the granulated mineral fibre – which provides the fire resistant characteristic of the Trafalgar FyrePlug pillows.

As the colour pigment is not expected to introduce any detrimental effect to the fire resistance performance of the pillow as a protection system, the FRL established in Table 10 and Table 11 can be maintained if the Trafalgar FyrePlug pillow with different colour were tested in accordance with AS 1530.4:2014 and assessed in accordance with AS 4072.1:2005.

7. Assessment of Trafalgar FyrePlug pillow as a blank seal

7.1 Proposed variations

The referenced tests included Trafalgar FyrePlug pillow installed in vertical and horizontal separating elements. In all the referenced tests, the pillows were penetrated by various types of services. It is proposed to assess the expected fire resistance performance of the Trafalgar FyrePlug pillows when installed in a vertical and horizontal separating element as a blank seal.

7.2 Methodology

The approach and method of assessment used for this assessment is summarised in Table 13

Table 13 Method of assessment

Assessment method	
Level of complexity	Intermediate assessment
Type of assessment	Qualitative

7.3 Assessment

Test SI 1562 was set up with FyrePlug Pillows filling up a 1810 mm long × 440 mm wide aperture in a 230 thick brick wall tested positively for 240 minutes in accordance with AS 1530.4:1975. When tested, the Trafalgar FyrePlug pillow was found to maintain the integrity and insulation performance for the whole duration of the 240 minutes test. This test result provides confidence in using the

Trafalgar FyrePlug pillows for large apertures to provide a flexible fire resistance barrier for building services penetrations of up to 240 minutes.

As no gaps were observed during the test on the tested pillow, the differences in the integrity criteria would not have affected the outcome of the test if tested in accordance with AS 1530.4:2014. However, due to the age of the test data and the highlighted variations between both standards summarised in Appendix C, the test results of this test will be taken at face value and will be considered as secondary test data

In all the recent test reports, the proposed Fyreplug pillows were tested while penetrated by other services. After review of the test reports, it was confirmed that all the pillows maintained the integrity and insulation throughout the test duration. At no point, any signs of gaps forming or flaming were observed. While the tested aperture in test report SI 1562 was 1810 mm × 440 mm, a conservative approach was followed where the maximum aperture is limited to 1000 mm × 300 mm.

8. Validity

Warringtonfire Australia does not endorse the tested or assessed product in any way. The conclusions of this assessment may be used to directly assess fire hazard, but it should be recognised that a single test method will not provide a full assessment of fire hazard under all conditions.

Due to the nature of fire 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 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 subject to constant review and improvement. It is therefore recommended that this report be reviewed on or, before, the stated expiry date.

This assessment represents our opinion about the performance likely to be demonstrated on a test in accordance with AS 1530.4:2014 and assessed in accordance with AS 4072.1:2005, based on the evidence referred to in this report.

This assessment is provided to Trafalgar Group for its own purposes and we cannot express an opinion on whether it will be accepted by building certifiers or any other third parties for any purpose.

Appendix A Summary of supporting test data

A.1 Test report– FP6372

Table 14 Information about test report FP6372

Item	Information about test report
Report sponsor	Fire Containment Pty Ltd
Test laboratory	BRANZ, 1222 Moonshine Road, Porirua 5381, New Zealand.
Test date	The fire resistance test was completed on 03/07/2018.
Test standards	The test was done in accordance with AS1530.4-2014.
Variation to test standards	None
General description of *tested specimens*	The tested specimens comprised four pipe penetrations and an access panel in a 75 mm thick Hebel PowerPanel wall. Specimen 1 consisted of a 100mm OD uPVC pipe with 100 mm Fyrechoke collars on each side and FyreFlex sealant to full depth in annular gap. The conduit extended 500 mm from the wall on the exposed side with its end capped and 2000 mm from the wall on the unexposed side with its end open. Specimen 2a consisted of a 25 mm OD uPVC conduit containing a fibre optic cable with 25 mm Fyrechoke collar on each side and FyreFlex sealant to full depth in annular gap. The conduit extended 500 mm from the wall on the exposed side with its end capped and 2000 mm from the wall on the unexposed side with its end open. Specimen 2b consisted of a 50 mm OD × 1.2 mm copper pipe with a 300 mm wide TWrap blanket on each side and FyreFlex sealant to full depth in the annular gap between the pipe and Hebel wall finished with 15 mm on each side. The pipe extended 500 mm from the wall surface and was capped at the end on the exposed side only. Specimen 3 consisted of a 450 mm × 450 mm Trafalgar FRC fire rated access panel installed on the unexposed side of the Hebel wall with 8 g × 100 mm plasterboard screws. The opening in the Hebel wall was trimmed all around with 75 mm × 50 mm × 1.2 mm slotted angles which were fixed with 8 g × 65 mm CSK plasterboard screws. Specimen 4 consisted of a 25 mm OD × 2.52 mm Pex-Al Pex gas pipe with Trafalgar FyrePex intumescent sealant in the annual gap to 25 mm depth and finished with a 35 mm fillet on each side. The specimen pipe protrudes 500 mm into the furnace side from the wall with the end capped.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:2014.

The test specimen achieved the following result:

Table 15 Results summary for this test report

Specimen	Penetration details	Integrity performance (minutes)	Insulation performance (minutes)	FRL
1	100 mm OD uPVC pipe with 100 mm Fyrechoke Collars on each side and FyreFlex sealant to full depth in annular gap.	125	125	-/120/120
2a	25 mm OD uPVC conduit containing a fibre optic cable with 25 mm Fyrechoke collar on each side and FyreFlex sealant to full depth in annular gap.	125	125	-/120/120

Specimen	Penetration details	Integrity performance (minutes)	Insulation performance (minutes)	FRL
2b	50 mm OD copper pipe with a 300 mm wide TWrap blanket on each side and FyreFlex sealant to full depth in the annular gap between the pipe and Hebel wall finished with a 15 mm fillet on each side.	125	117	-/120/90
3	450 mm × 450 mm Trafalgar FRC fire rated access panel installed on the unexposed side. Opening in the Hebel wall trimmed all around with 75 mm × 50 mm × 1.2 mm slotted angles	92	17	-/90/-
4	25 mm OD ×2.52 mm Pex-Al Pex gas pipe with Trafalgar FyrePex intumescent sealant in the annual gap to 25 mm depth and finished with a 35 mm fillet on each side.	125	125	-/120/120

A.2 Test report – FP11935-001

Table 16 Information about test report FP11935-001

Item	Information about test report
Report sponsor	Fire Containment Pty Ltd
Test laboratory	BRANZ, 1222 Moonshine Road Porirua 5381, New Zealand.
Test date	The fire resistance test was completed on 14/08/2019.
Test standards	The test was done in accordance with AS1530.4-2014.
Variation to test standards	None
General description of tested specimen	The specimen wall consisted of a nominally 2200 mm high × 1000 mm wide × 116 mm thick steel stud lined with two layers of 13 mm thick USG Boral Firestop plasterboard on each face. There were two 550 mm × 550 mm apertures, located one above the other, in the wall and were fitted with seven pipe and cable penetrations. The upper aperture was lined on the unexposed side with a layer of 60 mm thick Maxilite Board and included one cable tray and two copper pipe penetrations. The lower aperture was filled with FyrePlug pillows and included one cable tray, one copper pipe, one TPS cable bundle and one CAT6 cable bundle penetrations.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:2014.

The test specimen achieved the following result:

Table 17 Results summary for this test report

Specimen	Penetration details	Integrity performance (mins)	Insulation performance (mins)	FRL
1	100 mm OD copper pipe inserted through 60 mm thick Maxilite Board (800 mm × 800 mm) and clamped to an external frame on the unexposed side. FyreFlex sealant applied to the annular gap. Pipe was wrapped with TWrap insulation (nominal 75 mm overlap on each wrap) for 420 mm from the wall on exposed side and 600 mm on unexposed side.	180 – No failure	88	-/120/60
2	156 mm OD copper pipe inserted through 60 mm thick Maxilite Board (800 mm × 800 mm) and clamped to an external frame on the unexposed side. FyreFlex sealant applied to the annular gap. Pipe was wrapped with TWrap insulation (nominal 75 mm overlap on each wrap) for 420 mm from the wall on exposed side and 1,100 mm on unexposed side. The pipe had a double layer of TWrap for the first 300 mm on the unexposed side.	180 – No failure	104	-/120/90

Specimen	Penetration details	Integrity performance (mins)	Insulation performance (mins)	FRL
3	Cable tray with Appendix D power cables fitted through the upper aperture in the lower section of the Maxilite Board. FyreFlex sealant applied into gap between Maxilite Board and cable tray and cables on both faces. 300 mm × 300 mm TWrap insulation wrap (with no foil) placed over the cables the cable tray wrapped with a single 300 mm long TWrap insulation wrap on both faces (with a nominal overlap of 75 mm).	180 – No failure	144	-/120/120
4	Cable tray with Appendix power cables fitted through the lower aperture on top of prepacked FyrePlug pillows and the area of the aperture above the cable tray filled with FyrePlug Pillows. FyreFlex sealant applied around cables, cable tray and on FyrePlug pillows. 300 mm × 300mm TWrap insulation wrap (with no foil) placed over the cables on both faces and cable tray packed into the edges of the cable tray. The cable tray wrapped with a single 300 mm long TWrap insulation wrap on both faces (with a nominal overlap of 75 mm).	119 – cotton wool pad	150	-/90/120
5	100 mm OD copper pipe mounted on external frame on unexposed face and FyrePlug pillows packed into the aperture until filled. FyreFlex sealant applied around pipe circumference and on FyrePlug pillows on both exposed and unexposed faces. Pipe wrapped with 300 mm long layers of TWrap insulation (nominal 75 mm overlap on each wrap).	180 – No failure	180 – No failure	-/120/120
6	Bundle of 10 TPS PVC insulated cables laid on pre-packed FyrePlug pillows and the aperture filled with FyrePlug pillows packed above cable bundles. FyreFlex sealant applied to the cable bundles and FyrePlug pillows.	180 – No failure	159	-/120/120
7	Bundles of 20 CAT6 PVC insulated data cables laid on pre-packed FyrePlug pillows and the aperture filled with FyrePlug pillows packed above cable bundles. FyreFlex sealant applied to the cable bundles and FyrePlug pillows.	180 – No failure	173	-/120/120

A.3 Test report – FRT180323.3

Table 18 Information about test report

Item	Information about test report
Report sponsor	Trafalgar Group
Test laboratory	Warringtonfire Australia, Unit 2, 409-411 Hammond Road, Dandenong, Victoria 3175, Australia.
Test date	The fire resistance test was completed on 29/11/2018.
Test standards	The test was done in accordance with AS1530.4-2014.
Variation to test standards	The length of unprotected service on the unexposed face in penetration system B projected 690 mm from the unexposed side of the separating element, which is greater than the 500 mm prescribed in AS 1530.4:2014 Clause 10.4.2. Due to this variation an FRL rating could not be assigned to the tested penetration system B.
General description of tested specimen	The separating element consisted of a nominal 3000 mm × 3000 mm × 78 mm Speedpanel wall system with 15 varying penetration systems. These were protected by Trafalgar FyreFlex™ sealant, Trafalgar FYREPLEX™ HP sealant, Trafalgar Fyrechoke collars, Trafalgar FyrePlug pillows, Trafalgar FyreBox™ Maxi 650, and Maxilite Board. The service penetrations included copper pipes, cable bundles, PE-Xa pipes, Pe-Xb pipes, sprinkler pipes, CAT6 cables, uPVC pipes and conduits.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:2014.

The test specimen achieved the following result:

Table 19 Results summary for this test report

System		Penetration details	Criteria	Results	FRL
A	0	Speedpanel without penetrations	Structural adequacy	Not applicable	**-/120/30**
			Integrity	No failure at 121 minutes	
			Insulation	Failure at 38 minutes	
	1	DN100 type B copper pipe (1.63 mm wall thickness). FyrePlug pillows packed around the services and sealed together with FyreFlex sealant. A 300mm section of the TWrap wrapped around the pipe on the unexposed side and exposed side. FyrePEX sealant applied inside the Ø65 mm PVC pipe used as a pipe former	Structural adequacy	Not applicable	
			Integrity	No failure at 121 minutes	
			Insulation	Failure at 75 minutes	
	2	5 Nos of 2.5 mm^2 2C+E TPS cables and 5 Nos of CAT 6 cables. FyreFlex applied at the interface between the cable services and the pillows.	Structural adequacy	Not applicable	
			Integrity	No failure at 121 minutes	
			Insulation	No failure at 121 minutes	
	3		Structural adequacy	Not applicable	
			Integrity	No failure at 121 minutes	

System		Penetration details	Criteria	Results	FRL
		3C+E 185 mm^2 power cable, 4 Nos of 3C+E 16 mm^2 power cable, Ø25 mm PVC conduit with fibre optic cable and cable tray. The gaps between the 3C+E 185 mm^2 power cable, 3C+E 16 mm^2 power cable and 3C+E 16 mm^2 power cable and the fire pillow sealed with FyreFlex sealant. While the gaps between the Ø 25 mm uPVC conduit with fibre optic cable and the fire pillows were sealed with FyrePEX sealant. The interface between the pillows and the services were sealed with FyreFlex sealant with a nominal 30×30 mm fillet on both sides of the separating element.	Insulation	Failure at 87 minutes	
B		DN150 type b copper pipe. FyreFlex sealant applied in the annular gap to full depth finished with a nominal 30×30 mm fillet on both exposed and unexposed sides.	Structural adequacy	Not applicable	N/A (No FRL assigned as specimen set up was non-conforming).
			Integrity	No failure at 121 minutes	
			Insulation	Failure at 10 minutes	
C		3/8” + 3/4” Pair Coil with 19 mm Ardent FR insulation, 2.5 mm^2 2C+E circular Cable and Delta CAT6 Cable. FyreFlex sealant was applied at the annular gap to a depth of nominal 15 mm on both the exposed and unexposed side. Ø80 mm collar was retrofitted around the service on both the exposed and unexposed side. Annular gaps in the fire-collar between the service and the fire-collar were sealed with FyreFlex sealant.	Structural adequacy	Not applicable	-/120/90
			Integrity	No failure at 121 minutes	
			Insulation	Failure at 117 minutes	
D		Ø20 mm PE-Xa pipe. A backing rod was inserted to a depth of 60 mm from the unexposed side. FyrePEX HP sealant was then applied in the annular gap from the unexposed side to the backing rod.	Structural adequacy	Not applicable	-/120/120
			Integrity	No failure at 121 minutes	
			Insulation	No failure at 121 minutes	
E			Structural adequacy	Not applicable	-/120/120
			Integrity	No failure at 121 minutes	

System		Penetration details	Criteria	Results	FRL
		Ø20 mm PE-Xb pipe. A backing rod was inserted to a depth of 60 mm from the unexposed side. FyrePEX HP sealant was applied in the annular gap from the unexposed side to the backing rod.	Insulation	No failure at 121 minutes	
F		Ø20 mm PE-X-AL-PEX pipe. A backing rod was inserted to a depth of 60 mm from the unexposed side. FyrePEX HP sealant was applied in the annular gap from the unexposed side to the backing rod.	Structural adequacy	Not applicable	-/120/60
			Integrity	No failure at 121 minutes	
			Insulation	Failure at 60 minutes	
G		2 Nos of Delta CAT6 cables, 2 Nos of 2.5mm^2 2C+E Prysmian cable and 2 Nos of Firesense cable. FyreFlex sealant was applied at the annular gap to full depth of the separating element and finished with a nominal 30×30 mm fillet on both the exposed and unexposed sides.	Structural adequacy	Not applicable	-/120/120
			Integrity	No failure at 121 minutes	
			Insulation	No failure at 121 minutes	
H		3 Nos of 3C+E 16 mm^2 Electra Cables. FyreFlex sealant was applied at the annular gap to full depth of the separating element and finished with a nominal 30×30 mm fillet on both the exposed and unexposed side.	Structural adequacy	Not applicable	-/120/30
			Integrity	No failure at 121 minutes	
			Insulation	Failure at 46 minutes	
I	0	FyreBox Maxi consisting of a 650 mm wide × 125 mm high × steel frame	Structural adequacy	Not applicable	-/120/0
			Integrity	No failure at 121 minutes	
			Insulation	Failure at 36 minutes	
	1		Structural adequacy	Not applicable	
			Integrity	No failure at 121 minutes	

System		Penetration details	Criteria	Results	FRL
		Ø40 mm CPVC Sprinkler Pipe. A FyreBox Maxi was installed in the aperture on both the exposed and unexposed side. A nominal 10 mm annular gap was left around the outside of the FyreBox maxi and was filled with FyreFlex sealant to full depth of the separating element. The intumescent foam in the FyreBox Maxi was cut down the centre line, with two opening notched 5 mm undersize to allow a friction fit around the two services on both the exposed and unexposed side.	Insulation	Failure at 24 minutes	
	2	Ø60 mm CPVC Sprinkler Pipe. A FyreBox maxi was installed in the aperture on both the exposed and unexposed side. A nominal 10 mm annular gap was left around the outside of the FyreBox Maxi and was filled with FyreFlex sealant to full depth of the separating element. The FyreBox Maxi was cut down the centre line, with two opening notched 5 mm undersize to allow a friction fit around the two services on both the exposed and unexposed side.	Structural adequacy	Not applicable	
			Integrity	No failure at 121 minutes	
			Insulation	No failure at 121 minutes	
J		3/8” + 3/4” Pair Coil with 19 mm Ardent FR insulation, 2.5 mm^2 2C+E Electra Cable and Delta CAT6 Cable. A backing rod was inserted to a depth of 60 mm from the unexposed side. FyrePEX HP sealant was then applied in the annular gap from the unexposed side to the backing rod.	Structural adequacy	Not applicable	-/120/60
			Integrity	No failure at 121 minutes	
			Insulation	Failure at 79 minutes	
K		3/8” + 3/4” Pair Coil with PE insulation, 2.5mm^2 2C+E Electra Cable and Delta CAT6 Cable. A backing rod was inserted to a depth of 60 mm from the unexposed side. FyrePEX HP sealant was then applied in the annular gap from the unexposed side to the backing rod.	Structural adequacy	Not applicable	-/120/90
			Integrity	No failure at 121 minutes	
			Insulation	Failure at 115 minutes	

System	Penetration details	Criteria	Results	FRL
L	Blank seal. FyreFlex sealant was used to seal the Maxilite Board to the separating element, filling the grooves of the panel and finished with a nominal 15×15mm fillet along the perimeter. Maxilite Board over the aperture on the unexposed side.	Structural adequacy	Not applicable	-/90/60
		Integrity	Failure at 105 minutes	
		Insulation	Failure at 64 minutes	
M	Ø100 mm uPVC pipe. FyreFlex sealant was applied at the annular gap on both the exposed and unexposed side. Ø100 mm collar was retrofitted around the service on both the exposed and unexposed side of the wall.	Structural adequacy	Not applicable	-/120/60
		Integrity	No failure at 121 minutes	
		Insulation	Failure at 72 minutes	
N	Ø50 mm uPVC pipe. FyreFlex sealant was applied at the annular gap on both the exposed and unexposed side. Ø50 mm collar was retrofitted around the service on both the exposed and unexposed side.	Structural adequacy	Not applicable	-/120/60
		Integrity	No failure at 121 minutes	
		Insulation	Failure at 85 minutes	
O	Ø25 mm PVC conduit with 1 × fibre optic cable. FyreFlex sealant was applied at the annular gap on both the exposed and unexposed side. Micro collar was retrofitted around the service on both the exposed and unexposed side of the wall.	Structural adequacy	Not applicable	-/120/90
		Integrity	No failure at 121 minutes	
		Insulation	Failure at 113 minutes	

A.4 Test report – FRT190292.4

Table 20 Information about test report

Item	Information about test report
Report sponsor	Trafalgar Group
Test laboratory	Warringtonfire Australia, Unit 2, 409-411 Hammond Road, Dandenong, Victoria 3175, Australia.
Test date	The fire resistance test was completed on 16/01/2020.
Test standards	The test was done in accordance with AS 1530.4:2014
Variation to test standards	None
General description of tested specimen	The separating element consisted of a nominal 4500 mm × 3500 mm × 175 mm 40MPa normal weight concrete floor slab with 10 penetration systems and control joint. System A1 consisted of 15 × CAT 6 cables, 15 × fire alarm TPS cables, 15 × 2C+E 2.5 mm^2 TPS cables and 1 × small cable tray System A2 consisted of 1 × D2 communication cable and 1 × small cable tray System A3 consisted of 1 × D1 power cable and 1 × small cable tray. System A1 to A3 were protected by Trafalgar FyreFlex™ sealant. System B consisted of 1 × DN100 type B copper pipe with Trafalgar TWrap and Trafalgar FyreFlex™ sealant System C consisted of 1 × DN50 type B copper pipe with Trafalgar TWrap and Trafalgar FyreFlex™ sealant System D consisted of 40 mm wide control joint with Trafalgar FyreFlex™ sealant System E1 consisted of 1 × D1 power cables and 1 × small cable tray with Trafalgar TWrap and Trafalgar FyreFlex™ sealant System E2 consisted of 1 × DN100 type B copper pipe with Trafalgar TWrap and Trafalgar FyreFlex™ sealant System E3 consisted of 1 × DN150 type B copper pipe with Trafalgar TWrap, Trafalgar FyreFlex™ sealant, and Trafalgar Maxilite Board 30 mm System E4 consisted of 1 × M10 threaded rod with Trafalgar TWrap and Trafalgar FyreFlex™ sealant System F consisted of 8 × 3/8” + 3/4” pair coils, 3 × 1/4” + 1/2” pair coils, 11 × 2C 10 mm^2 + E × 4 mm^2 power cables, 11 × CAT 6 cables and 1 × NBN cable with Trafalgar TWrap and Trafalgar FyreFlex™ sealant System G consisted of 1 × NB150 MD steel pipe with Trafalgar TWrap and Trafalgar FyreFlex™ sealant System H consisted of 1 × drink python with Trafalgar FyreBox™ Mini 150-R and Trafalgar FyreFlex™ sealant System I1 consisted of 2 × 1/4” + 1/2” pair coils, 2 × 2C 10 mm^2 + E × 4 mm^2 power cables and 2 × CAT6 cables with Trafalgar FyreBox™ Mini 100-R and Trafalgar FyreFlex™ sealant System I2 consisted of 1 × D1 power cable, 1 × D2 communication cable and 1 × large cable tray with Trafalgar TWrap and Trafalgar FyreFlex™ sealant System I3 consisted of 15 × fire alarm TPS cables with Trafalgar FyreFlex™ sealant System I4 consisted of 20 × CAT 6 cables and 1 × NBN cable with Trafalgar FyreFlex™ sealant System J1 consisted of 1 × D2 communication cable and 1 × small cable tray with Trafalgar TWrap and Trafalgar FyreFlex™ sealant. System J2 consisted of 1 × D1 power cable and 1 × small cable tray with Trafalgar TWrap and Trafalgar FyreFlex™ sealant
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:2014.

The test specimen achieved the following result:

Table 21 Results summary for this test report

Penetration system and control joint		Service	Criteria	Results	FRL
A	1	15 × CAT 6 cables 15 × fire alarm TPS cables 15 × 2C+E 2.5 mm² TPS cables 1 × small cable tray	Structural adequacy	Not applicable	**-/120/60**
			Integrity	No failure at 241 minutes	
			Insulation	Failure at 144 minutes	
	2	1 × D2 communication cable 1 × small cable tray	Structural adequacy	Not applicable	
			Integrity	Failure at 152 minutes	
			Insulation	Failure at 79 minutes	
	3	1 × D1 power cable 1 × small cable tray	Structural adequacy	Not applicable	
			Integrity	Failure at 223 minutes	
			Insulation	Failure at 77 minutes	
B		1 × DN100 type B copper pipe	Structural adequacy	Not applicable	**-/240/60**
			Integrity	No failure at 241 minutes	
			Insulation	Failure at 60 minutes	
C		1 × DN50 type B copper pipe	Structural adequacy	Not applicable	**-/240/60**
			Integrity	No failure at 241 minutes	
			Insulation	Failure at 74 minutes	
D		40 mm wide control joint	Structural adequacy	Not applicable	**-/240/120**
			Integrity	No failure at 241 minutes	
			Insulation	Failure at 158 minutes	
E	1	1 × D1 power cables 1 × small cable tray	Structural adequacy	Not applicable	**-/15/15**
			Integrity	No failure at 241 minutes	
			Insulation	Failure at 154 minutes	
	2	1 × DN100 type B copper pipe	Structural adequacy	Not applicable	
			Integrity	Failure at 214 minutes	
			Insulation	Failure at 150 minutes	
	3	1 × DN150 type B copper pipe	Structural adequacy	Not applicable	

Penetration system and control joint		Service	Criteria	Results	FRL
			Integrity	Failure at 28 minutes	
			Insulation	Failure at 28 minutes*	
	4	1 × M10 threaded rod	Structural adequacy	Not applicable	
			Integrity	No failure at 241 minutes	
			Insulation	No failure at 241 minutes	
	F	8 × 3/8” + 3/4” pair coils 3 × 1/4” + 1/2” pair coils 11 × 2C 10 mm^2 + E × 4 mm^2 power cables 11 × CAT 6 cables 1 × NBN cable	Structural adequacy	Not applicable	**-/120/90**
			Integrity	Failure at 130 minutes	
			Insulation	Failure at 115 minutes	
	G	1 × NB150 MD steel pipe	Structural adequacy	Not applicable	**-/240/120**
			Integrity	No failure at 241 minutes	
			Insulation	Failure at 170 minutes	
	H	1 × drink python	Structural adequacy	Not applicable	**-/240/240**
			Integrity	No failure at 241 minutes	
			Insulation	No failure at 241 minutes	
I	1	2 × 1/4” + 1/2” pair coils 2 × 2C 10 mm^2 + E × 4 mm^2 power cables 2 × CAT6 cables	Structural adequacy	Not applicable	**-/120/90**
			Integrity	No failure at 241 minutes	
			Insulation	Failure at 103 minutes	
	2	1 × D1 power cable 1 × D2 communication cable 1 × large cable tray	Structural adequacy	Not applicable	
			Integrity	Failure at 147 minutes	
			Insulation	Failure at 96 minutes	
	3	15 × fire alarm TPS cables	Structural adequacy	Not applicable	
			Integrity	No failure at 241 minutes	

Penetration system and control joint		Service	Criteria	Results	FRL
			Insulation	Failure at 181 minutes	
	4	20 × CAT 6 cables 1 × NBN cable	Structural adequacy	Not applicable	
			Integrity	Failure at 193 minutes	
			Insulation	Failure at 193 minutes*	
J	1	1 × D2 communication cable 1 × small cable tray	Structural adequacy	Not applicable	-/120/90
			Integrity	Failure at 131 minutes	
			Insulation	Failure at 108 minutes	
	2	1 × D1 power cable 1 × small cable tray	Structural adequacy	Not applicable	
			Integrity	No failure at 241 minutes	
			Insulation	Failure at 113 minutes	

A.5 Test report – FRT190298.1

Table 22 Information about test report

Item	Information about test report
Report sponsor	Trafalgar Group
Test laboratory	Warringtonfire Australia, Unit 2, 409-411 Hammond Road, Dandenong, Victoria 3175, Australia.
Test date	The fire resistance test was completed on 23/01/2020.
Test standards	The test was done in accordance with AS1530.4-2014.
Variation to test standards	None
General description of tested specimen	The test specimen consisted of a Speedpanel wall system (1600 mm × 1600 mm × 78 mm) penetrated by two penetration systems and an access panel protected with Trafalgar TWrap, Trafalgar Fyrchoke collar and Trafalgar and FyreFlex sealant.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:2014.

The test specimen achieved the following result:

Table 23 Results summary for this test report

Penetration system / access panel	Penetration services	Criteria	Results	Fire resistance level (FRL)
A	100NB steel pipe protruding 500 mm on the exposed side and 750 mm on the unexposed side. The pipe was sealed with FyreFlex sealant from both sides of the wall to the full depth of the Speedpanel. Two 300 mm wide strips of TWrap were applied longitudinally along the unexposed face of the pipe to a length of 450 mm.	Structural adequacy	Not applicable	**-/120/90**
		Integrity	No failure at 121 minutes	
		Insulation	Failure at 113 minutes	
B	DN100 uPVC pipe protruding 500 mm on the exposed side and nominally 2000 mm on the unexposed side. Serviced protected with Maxilite Board fixed into place over the aperture on the unexposed face. FyreFlex sealant was applied to all joins in the Maxilite Board and through the ribbed profile of the Speedpanel behind the Maxilite. Sealant was also applied to the annular gaps around the pipe on the exposed face to a nominal depth of 10 mm.	Structural adequacy	Not applicable	**-/120/120**
		Integrity	No failure at 121 minutes	
		Insulation	No failure at 121 minutes	
C	600 mm × 600 mm Access Panel. The unexposed face of the opening was lined with 100 mm wide strips of 13 mm fire rated plasterboard. FyreFlex sealant was applied to the inside edge of the opening and the access panel was mounted through the unexposed side. FyreFlex sealant was used to fill any gaps behind the flanges on the unexposed face.	Structural adequacy	Not applicable	**-/120/45**
		Integrity	No failure at 121 minutes	
		Insulation	Failure at 49 minutes	

A.6 Test report – NI 0387-2

Table 24 Information about test report

Item	Information about test report
Report sponsor	Masterbilt Industries
Test laboratory	Fire Research Laboratories, 59 Normanby Road, Notting Hill, Victoria 3168, Australia.
Test date	The fire resistance test was completed on 04/03/1987.
Test standards	The test was done in accordance with AS1530.4-1985.
Variation to test standards	None
General description of tested specimen	The test construction consisted of a 3 hr fire rated 140 mm thick × 2720 mm wide × 1620 mm high concrete block wall with an opening of 800 mm wide × 600 mm high located centrally and at 400 mm above the base of the wall. Three groups of services were erected through the opening: • a length of 90 mm O.D. steel water pipe • a group of 8 PVC covered 220/415 V power cables, comprising 2 × Ø 12 mm, 2 × Ø 18 mm and 4 × Ø 20 mm on a 150 mm wide perforated galvanised steel cable tray, and • a rectangular bundle of 60 PVC covered 100-wire telecommunication cables, bundles with flat steel strap retainers at 600 mm intervals. Fyre Pillows were packed into the opening around the services using a total of 60 size F.R.P. 1 (300 mm × 300 mm × 40 mm) and 14 F.R.P. 2 (300 mm × 220 mm × 40 mm. The interfaces between the pillows and the three service penetrations were sealed to a depth of approximately 50 mm from the surface of the wall with Firecaulk foaming sealant. A bead of the foaming sealant was applied to the annular gap between the pillows and the surface of the wall opening. The telecommunication cable bundle and the power cables with tray, including the steel pipe, were given two coats of Fyretex intumescent compound over 600 mm lengths extending through the pillows and protruding 300 mm beyond the unexposed face. An Insulgard heat shielding system was erected around each of the penetrations on the unexposed face of the specimen, covering a length of 250 mm extending outward from the unexposed face. The Insulgard consisted of a flexible outer shielding element of small aperture expanded steel mesh designed to wrap around the service element or group of elements and distanced from the hot surfaces by a specially designed low conduction flexible metal profile spacing system. The services extended 2000 from the wall on the unexposed side and 100 mm from the wall into the surface.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:1985.

The test specimen achieved the following result:

Table 25 Results summary for this test report

Separating wall element and service penetrations	Fire Resistance Performance		
	Integrity (minutes)	Insulation (minutes)	FRL
800 mm × 600 mm opening in a 140 mm thick concrete block wall system of 3 hr fire resistance rating incorporating these 3 groups of services passing through the opening: • A 90 mm OD steel water pipe. • A group of 8 PVC covered 220/415 V power cables, comprising 2 × Ø 12 mm, 2 × Ø 18 mm and 4 × Ø 20 mm on a 150 mm wide perforated galvanised steel cable tray.	184	184	-/180/180

Separating wall element and service penetrations	Fire Resistance Performance		
	Integrity (minutes)	Insulation (minutes)	FRL
• a rectangular bundle of 60 PVC covered 100-wire telecommunication cables, bundles with flat steel strap retainers at 600 mm intervals. The services were protected by Fyre Pillows packed between the services within the opening. The gaps at the interface between the pillows and the services were filled with Firecaulk foaming sealant to a depth of 50 mm and a bean of the sealant was also applied along the perimeter interface. The cables, cable tray and the steel pipe were given 2 coats of Fyretex intumescent sealant over 600 mm lengths, extending through the pillows to 300 mm beyond the unexposed face. The unexposed side of each service was wrapped with Insulguard over a length of 250 mm from the wall.			

A.7 Test report – NI 0790

Table 26 Information about test report

Item	Information about test report
Report sponsors	Wormald International, Boral Australian Gypsum and CSR.
Test laboratory	Fire Research Laboratories, 59 Normanby Road, Notting Hill, Victoria 3168, Australia.
Test date	The fire resistance test was completed on 18/04/1990.
Test standards	The test was done in accordance with AS1530.4-1990.
Variation to test standards	None
General description of tested specimen	The test construction consisted of a 95 mm thick 2 hr fire rated shaft wall 2540 mm high × 1930 mm wide. A deflection head detail was provided at the top of the wall with the plasterboard sheets terminated 20 mm below the head. A central vertical control joint of 22 mm through gap was provided. Both the control joint and the deflection head were fire stopped with FyreFlex sealant. The following services penetrated the shaft wall: • Service A – 100 mm uPVC pipe fire stopped with a Fyrechoke wall collar. The pipe had 110 mm OD with 3.2 mm wall thickness. • Service B – 200 mm copper pipe fire stopped with FyreFlex. The pipe was 203 mm OD with 2.03 mm wall thickness. • Service C – 150 mm copper pipe fire stopped with FyreFlex. The pipe had 203 mm OD with 2.03 mm wall thickness. • Service D – Assorted power cables supported by 390 mm cable tray and fire stopped by FyreFlex. The cables were – – One 41 mm OD single core power cable with 127 conductors, each approximately 2.52 mm diameter. The sheathing was double, comprising an outer 2 mm thick black PVC layer and a 2.4 mm thick red PVC inner layer. – One38 mm OD single core power cable wth127 aluminium conductors, each approximately 2.52 mm diameter. The sheathing was double, comprising an outer 2 mm thick black PVC layer and a 2.4 mm thick red PVC inner layer. – Three 16 mm OD single core power cables. Each cable comprised 37 copper conductors, each of approximately 1.78 mm diameter. The conductors were sheathed with 1.6 mm thick red PVC. – Three 14 mm OD single core power cables. Each cable comprised 19 aluminium conductors, each of approximately 1.78 mm diameter. The conductors were sheathed with 1.4 mm thick red PVC. – One 54 mm OD 3 core plus earth PVC insulated, PVC sheathed power cable. Each earth core comprised 19 copper wires, each of 2.14 mm diameter. – Four 20 mm OD diameter 3 core plus earth PVC insulated, PVC sheathed cables. Each power core comprised 7 copper wires each approximately 1.7 mm diameter. The earth core comprised 7 copper wires each approximately 1.04 mm diameter. • Service E – Bundle of 10 × 6 telecommunication cables supported by a 190 mm cable tray, penetrating a 400 mm × 300 mm opening in the shaft wall and fire stopped with a combination of FyrePlug Pillows and FyreFlex. Services A and B were erected in position before the shaft wall was built, simulating pre-existing services.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:1990.

The test specimen achieved the following result:

Table 27 Results summary for this test report

Item	Description	Fire Resistance Performance	
		Integrity (mins)	Insulation (mins)
-	Deflection head	No failure at 127	110
-	Control joint – 22 mm wide	No failure at 127	105
Service A	100 mm uPVC pipe fire stopped with a Fyrechoke wall collar. The pipe had 110 mm OD with 3.2 mm wall thickness	No failure at 127	No failure at 127
Service B	200 mm copper pipe fire stopped with FyreFlex. The pipe was 203 mm OD with 2.03 mm wall thickness	No failure at 127	0*
Service C	150 mm copper pipe fire stopped with FyreFlex. The pipe had 203 mm OD with 2.03 mm wall thickness.	No failure at 127	0*
Service D	Assorted power cables supported by 390 mm cable tray and fire stopped by FyreFlex.	No failure at 127	59
Service E	Bundle of 10 × 6 telecommunication cables supported by a 190 mm cable tray	No failure at 127	92
Note - * insulation level not measured			

A.8 Test report – NI 4189

Table 28 Information about test report

Item	Information about test report
Report sponsor	Wormald International
Test laboratory	Fire Research Laboratories, 59 Normanby Road, Notting Hill, Victoria 3168, Australia.
Test date	The fire resistance test was completed on 16/11/1989.
Test standards	The test was done in accordance with AS 1530.4:1985.
Variation to test standards	None
General description of tested specimen	The test construction comprised a 75 mm thick E-core floor panel with a central opening 400 mm long × 400 mm wide. The following services were fitted through the opening: • Service A - 100 mm copper pipe, 101 mm OD and 1.2 mm wall thickness. • Service B – 7 × 4 bundle of 28 telecommunication cables, each of 15 mm diameter with 100 strands. Each strand comprised a 0.5 mm diameter central copper conductor insulated with PVC. The strands were bundled and sheathed in 1.2 mm thickness PVC. • Service C – 200 mm cable tray with assorted power cables comprising: – a 43 mm OD single core power cable consisting of 127 copper conductors, 2.5 mm diameter with a 2.5 mm thick inner black PVC sheath and a 3 mm thick outer black PVC sheath. – Three 16 mm diameter 3-core plus earth PVC insulated, PVC sheathed power cables. Each power core comprised 7 copper wires of 1 mm diameter each. The power and earth cores were sheathed with orange PVC of approximately 1.7 mm thickness. – Three 20 mm OD single core power cables. Each cable comprising 37 copper conductors each approximately 2.25 mm diameter with approximately 2.0 mm thick red PVC sheath. – One 21 mm OD multicore PVC insulated, PVC sheathed control cable with 25 cores. Each core comprised 7 copper wires, each approximately 0.5 mm diameter insulated with PVC approximately 1.5 mm thick. All cores were sheathed with orange PVC approximately 2 mm diameter. – One 24 mm OD 3-core plus earth, PVC insulated, PVC sheathed power cable. Each power core comprised 19 copper wires, each approximately 1.35 mm diameter. The earth core comprised 7 copper wires each approximately 1.04 mm diameter. The power cores were insulated with PVC approximately 1.5 mm thick and the earth core was insulated with PVC approximately 1 mm thick. The power and earth cores were sheathed with orange PVC approximately 2 mm diameter. The cable tray and cables were 2275 mm long, projected 300 mm from the underside of the E-core panel into the furnace and a minimum 2000 mm above the upper surface of the E-core panel. The opening was filled by packing with FyrePlug pillows consisting of 21 size FR P1 – 300 mm × 300 mm × 40 mm thick and 1 size FR P2- 300 mm × 250 mm × 40 mm thick. The pillows were packed around all services. FyreFlex was applied to the interface between the FyrePlug pillows, the services and E-core. The services protruded 200 mm from the underside of the E-core into furnace and 2000 mm above the upper surface of the E-core panel. The pipe was capped at the exposed end and open at the opposite end.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:1985.

The test specimen achieved the following result:

Table 29 Results summary for this test report

Item	Description	Fire resistance performance	
		Integrity (minutes)	Insulation (minutes)
Fireplug pillows	Fireplug pillows covering sections of the opening in the E-core panel unpenetrated.	No failure at 124	123
Service A	100 mm copper pipe, 101 mm OD and 1.2 mm wall thickness.	No failure at 124	14
Service B	7 × 4 bundle of 28 telecommunication cables, each of 15 mm diameter with 100 strands. Each strand comprised a 0.5 mm diameter central copper conductor insulated with PVC. The strands were bundled and sheathed in 1.2 mm thickness PVC	No failure at 124	64
Service C	200 mm cable tray with assorted power cables comprising: • A 43 mm OD single core power cable. • Three 16 mm diameter 3-core plus earth PVC insulated, PVC sheathed power cables. • Three 20 mm OD single core power cables. • One 21 mm OD multicore PVC insulated, PVC sheathed control cable with 25 cores. • One 24 mm OD 3-core plus earth, PVC insulated, PVC sheathed power cable. The cable tray and cables were 2275 mm long, projected 300 mm from the underside of the E-core panel into the furnace and a minimum 2000 mm above the upper surface of the E-core panel.	No failure at 124	55
The opening was filled by packing with FyrePlug pillows. FyreFlex was applied to the interface between the FyrePlug pillows, the services and E-core. In accordance with AS 1530.4:1985 the FyrePlug pillows and the service penetration systems protected by the FyrePlug pillows and FyreFlex sealant all achieved a fire resistance rating of 2 hr.			

A.9 Test report – SI 1562

Table 30 Information about test report

Item	Information about test report
Report sponsor	Fire Research Pty Ltd
Test laboratory	Department of Housing and Construction- Experimental Building Station (facility now under CSIRO).
Test date	The fire resistance test was completed on 23/04/1982.
Test standards	The test was done in accordance with AS 1530.4:1975.
Variation to test standards	None
General description of tested specimen	The test construction comprised a 1810 mm long × 440 mm high × 230 mm thick wide opening in a brick wall. Fire Research fire resistant pillows which consisted of two sizes, of which the larger was 310 mm long × 310 mm wide and the half size pillow was 310 mm long × 200 mm wide. Both pillows were nominally 40 mm thick and fabric cases each filled with mineral fibres. The pillows were placed with the 310 mm length over the 230 mm opening width. The ends of the pillows were lightly tamped so that the installed thickness of the pillows was approximately 250 mm. The pillows were stacked until the opening was filled by the pillows using both the large and half size pillows.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:1975.

The test specimen achieved a fire resistance performance of 240 minutes in integrity (from observation of no flaming or collapse of the pillow stack over the wall opening) and 240 minutes in insulation. The specimen was assigned a four hour fire rating.

A.10 Test report – SI 1614

Table 31 Information about test report

Item	Information about test report
Report sponsor	Fire Research Pty Ltd
Test laboratory	Department of Housing and Construction- Experimental Building Station (facility now under CSIRO).
Test date	The fire resistance test was completed on 04/08/1982.
Test standards	The test was done in accordance with AS 1530.4-1975.
Variation to test standards	None
General description of tested specimen	The specimen incorporated two systems for protecting openings of 1,000 mm long × 700 mm wide formed in a 150 mm thick reinforced concrete floor to facilitate the installation of services such as telecommunication cables. The perimeter along the long slab edges were reinforced with 45 mm × 25 mm × 1.6 mm steel angles and the narrow sides were fitted with 45 mm square × 1.2 mm plate steel RHS forming mullion supports which act as joints between side by side slots forming continuous lengths of multiple slots 700 mm wide along the floor slab as required. System 1 was described a rigid fire stop and consisted of vermiculite-based panels with a supporting steel frame. System 2 was described as a flexible fire stop and consisted of flexible pillows. As the pillows were limited to installations in 200 mm maximum slot widths to ensure the pillows do not fall off, the 700 mm wide slot was divided into small modular frames of 200 mm maximum width using 25 mm square × 1.2 mm steel tube dividers secured to the concrete on the unexposed side. Each system was designed for installation in slots up to 700 mm wide and of indefinite length in concrete floors. The test specimen incorporated two modular sections of each system. One modular section of each system incorporated penetrating services consisting of two bundles of power cables. One bundles of power cables in each system was fitted with a steel mesh sleeve to prevent combustible material from coming in contact with the cables, whilst the other bundle in each system was not so fitted.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:1975.

The test specimen achieved the following result:

Table 32 Results summary for this test report

Item	Description of service penetration	Fire stopping system	Fire resistance performance	
			Integrity (minutes)	Insulation (minutes)
System A	Two packs each with a group bundle consisting of 4 ×Ø25 mm Pyrotenax metal sheathed power supply cables. One bundle was fitted with steel mesh sleeve.		No failure at 182	Cables with sleeve: • 49 on panel • 17 on cables at 25 mm • 60 on cables at 400 mm

Item	Description of service penetration	Fire stopping system	Fire resistance performance	
			Integrity (minutes)	Insulation (minutes)
		100 mm thick rigid vermiculite-based fire barrier panels installed in the floor within modular steel support frames connected by steel bracing cross members to create a slot opening 700 mm wide and 150 mm deep. Annular gaps around service penetrations and local joints in panel were filled to a depth of 20mm with a foaming intumescent sealant		Cables with sleeve: No failure on panel or cables
	Panel only without service penetrations		No failure at 182	158 on joint No failure on panel at 182
Service B	Two packs each with a group bundle consisting of 4 × Ø 25 mm Pyrotenax metal sheathed power supply cables. One bundle was fitted with steel mesh sleeve.	310 mm high × 310 mm wide × 40 mm thick fabric pillows filled with mineral fibres placed over the floor slot opening and around the penetrating service power cable bundles. 2 winds of intumescent bandage 200 mm overall height wrapped around each pack of power cables.	No failure at 182	Cables without sleeve: • 95 on pillows • 34 on cables at 25 mm • 83 on cables at 400 mm
				Cables with sleeve: No failure on pillows or cables
	Pillows only without service penetrations		No failure at 182	167

A.11 Test report – FRT200257

Table 33 Information about test report

Item	Information about test report
Report sponsor	Trafalgar Group
Test laboratory	Warringtonfire Australia, Unit 2, 409-411 Hammond Road, Dandenong, Victoria 3175, Australia.
Test date	The fire resistance test was completed on 10/02/2021.
Test standards	The test was done in accordance with AS1530.4-2014.
Variation to test standards	None
General description of tested specimen	The separating element consisted of a 1760 mm × 1200 mm × 120 mm normal weight concrete floor slab with three penetration systems A, B and C System A consisted of 1 × Ø25 mm PE-Xa/Al/PE, 8 × 16 mm2 3C+E power cables, 1 × 3/8 + 3/4 FR pair coil w/ 13 mm insulation and 1 × 1/4 + 3/8 FR pair coil w/ 13 mm insulation. The system was protected by Trafalgar FyreSet FR mortar, FyreBox cast-in 350 × 125, TWrap and FyreFlex sealant. System B consisted of 1 × DN 50 type B copper pipe and 1 × DN 100 type B copper pipe. The system was protected by Trafalgar TWrap, FyreFlex sealant and FyrePlug pillows. System C consisted of 1 × DN 150 type B copper pipe. The system was protected by Trafalgar Insulguard and FyreFlex sealant.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:2014.

The test specimen achieved the following result:

Table 34 Results summary for this test report

Penetration system		Criteria	Results	Fire resistance level (FRL)
A		Structural adequacy	Not applicable	-/120/120
		Integrity	Failure at 137 minutes	
		Insulation	Failure at 137 minutes	
B	Main fire-stopping protection	Structural adequacy	Not applicable	-/180/120
		Integrity	No failure at 181 minutes	
		Insulation	Failure at 162 minutes	
	1	Structural adequacy	Not applicable	
		Integrity	No failure at 181 minutes	
		Insulation	Failure at 152 minutes	
	2	Structural adequacy	Not applicable	
		Integrity	No failure at 181 minutes	
		Insulation	Failure at 156 minutes	
C		Structural adequacy	Not applicable	-/180/120
		Integrity	No failure at 181 minutes	
		Insulation	Failure at 126 minutes	

Appendix B Relevance of AS 1530.4:1975 test data with respect to AS 1530.4:2014

The referenced fire resistance tests SI 1562 and SI 1614 was conducted in accordance with AS 1530.4:1975, which differs slightly from AS 1530.4:2014. These minor variations and their potential effect on the fire resistance performance of the referenced test specimens are discussed below.

B.1 Discussion

Furnace thermocouples

The furnace thermocouples specified in AS 1530.4:2014 are type K, mineral insulated metal sheathed (MIMS), with a stainless-steel sheath having a wire of diameter 1.0 mm and an overall diameter of 3mm. The measuring junction protrudes 25 mm from the supporting heat resistant tube.

The furnace thermocouples specified in AS 1530.4:1975 are not nominated.

There would likely be more influence on results due to the difference in heat transfer conditions between furnaces, which are not fully controlled by the current fire resistance test standards, rather than the minor differences in the thermocouple construction.

The positioning of furnace thermocouples from the exposed face of the specimen at the start of the fire resistance test were required to be between 75 mm and 300 mm in AS 1530.4:1975. In AS 1530.4:2014, the distance is required to be 100 mm + 10 mm.

As the furnace should be adequately insulated, any possible temperature disparities inside the furnace are expected to be minimal. Therefore, the minor variation in the location of the furnace thermocouples, relative to the exposed face of the specimen, would not significantly affect the test results.

Furnace pressure

The furnace pressure required by AS 1530.4:1975 is not nominated.

AS 1530.4:2014 requires a minimum pressure differential of 15Pa ± 3Pa above the laboratory atmosphere at the centre of the lowest penetration for vertical specimens and 20 Pa ± 3 Pa at 100 mm below the soffit for horizontal specimens.

AS 1530.4:1975 does not nominate a pressure and the pressure was not recorded for the reference test.

In absence of any gaps, cracks or fissures forming in the reference test, it is unlikely that a variation in pressure between the two methods would have an impact on the performance of the test at the junction of the damper and the wall.

The variations in furnace pressure conditions are not expected to have significant effect on the outcome of the referenced fire resistance tests at the junction of the damper and the wall.

It is a requirement of AS 1530.4:2014 that for vertical elements a furnace gauge pressure of zero (0) Pa is established at a height of 500 mm above the notional floor level. Therefore, at the top of a vertical specimen 3000 mm high and based on a pressure gradient of 8.5 Pa/m for typical furnace conditions, the pressure could potentially be 21.2 Pa.

The potential difference in specified furnace pressures between the standards is not expected to be significant, provided the integrity of the specimen is maintained. Furthermore, given that the specified tolerances are +3 Pa, the minor variation in furnace pressure is not expected to have significantly affected the outcome of the referenced fire resistance test.

Integrity criteria

The integrity criteria differ slightly between AS 1530.4:2014 and AS 1530.4:1975.

At the junction of the damper or aperture and wall the specimen is deemed to have failed the integrity criterion in accordance with AS 1530.4:2014 when any of the following occur:

- Sustained flaming on the unexposed face (10 seconds).

- Ignition of cotton pad when it is applied for up to 30 seconds (for elements not exceeding insulation).
- Development of a gap through which a 6mm gap gauge can pass through to the furnace and moved 150 mm along, or development of a gap through which a 25 mm gap gauge can pass through to the furnace.
- The cotton pad test is by observation, not included in an AS 1530.4:1975 compliant test; however, it is not applied after the specimen has exceeded insulation.

The integrity criteria for AS 1530.4:1975 are similar. A specimen is deemed to have failed integrity if a crack or fissure opens during the test that allows the passage of hot gases or flames.

The differences in these criteria are therefore not likely to result in significant integrity performance or the AS 1530.4:1975 result will be more stringent.

Insulation criteria

The insulation criteria of AS 1530.4:1975 and AS 1530.4:2014 remain the same, although the location of thermocouples has been revised. These differences are not considered relevant to the performance of the proposed construction.

As no gaps were observed during the test on the tested construction or at the junction of the damper and the wall, the differences in the integrity criteria would not have affected the outcome of the test if tested in accordance with AS 1530.4:2014.

Applicability of test data to AS 1530.4:2014

In the absence of any integrity failure observed on the unexposed faces of the specimen tested and the basis of the discussion above, it is concluded that: the test results obtained from the referenced fire resistance tests – in accordance with AS 1530.4:1975 – can be applied to assess the likely fire resistance performance at the junction of the damper and the wall, if tested in accordance with AS 1530.4:2014.

Appendix C Relevance of AS 1530.4:1985 test data with respect to AS 1530.4:2014

The referenced fire resistance tests NI 03872 and NI 4189 was conducted in accordance with AS 1530.4:1985, which differs slightly from AS 1530.4:2014. These minor variations and their potential effect on the fire resistance performance of the referenced test specimens are discussed below.

C.1 Discussion

Furnace 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 1530.4:1985. The specified specimen heating rate in AS 1530.4:1985 is given by:

$$T_t - T_0 = 345log_{10}(8t + 1)$$

AS 1530.4:2014 specifies furnace temperature follows the trend below:

$$T_{AS1530.4-2014} = 345log_{10}(8t + 1) + 20$$

Where:

T_t = furnace temperature at time t, in °C.

T_0 = initial furnace temperature at time t, in °C, ≥10°C and ≤ 40°C.

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

The heating regimes in AS 1530.4:1985 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, but 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 1530.4:1990 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 1530.4:1985 are not appreciably different.

Furnace overpressure

AS 1530.4:1985 requires a minimum pressure differential of 8 Pa above the laboratory atmosphere for both vertical and horizontal specimens.

AS 1530.4:2014 requires a minimum pressure differential of 15 Pa ± 3 Pa above the laboratory atmosphere, at the centre of the lowest penetration for vertical specimens and 20 Pa ± 3 Pa at 100 mm below the soffit for horizontal specimens.

The increase in furnace overpressure is only expected to be significant if cracks or fissures have developed in the test specimen.

Performance criteria

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

- structural adequacy
- integrity
- insulation

Structural adequacy

The structural adequacy criteria are not relevant to this test.

Integrity

The specimen shall be deemed to have failed regarding the service penetrations, in accordance with AS 1530.4:2014, 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.

The integrity criterion varies slightly between AS 1530.4:1985 and AS 1530.4:2014. The specimen is deemed to have failed to AS 1530.4:1985 if the specimen:

- collapses.
- develops cracks, fissures or, other openings through which flames or hot gases can pass.
- sustained flaming on the non-fire side in excess of 10 seconds.

The integrity criterion in accordance with AS 1530.4:1985 is generally more stringent. Integrity failure would normally occur prior to failure in accordance with AS 1530.4:2014.

Insulation

The insulation criteria of AS 1530.4:1985 and AS 1530.4:2014 remain the same, although the location of thermocouples has been revised. These differences are not considered relevant to performance of the proposed construction.

Application of the test data to AS 1530.4:2014

In general, the furnace exposure conditions of AS 1530.4:1985 are not appreciably different to AS 1530.4:2014.

The difference in specified furnace pressures between the revisions of AS 1530.4 (1985 to 2014) is only expected to be significant if cracks or fissures have developed in the test specimen, as higher furnace overpressure has a greater tendency to force hot gases from the furnace to the non-fire side, with potentially adverse effects on both integrity and insulation performance.

Test NI 03872 did not record any integrity failure for the whole duration of the 184 minutes of the test.

Test NI 4189 did not record any integrity failure for the whole duration of the 124 minutes of the test.

Based on the above discussion, it is considered that integrity performance of the tests NI 03872 and NI 4189 can be used to assess the integrity performance of the proposed construction if subjected to a fire resistance test in accordance with AS 1530.4:2014.

Appendix D Relevance of AS 1530.4:1990 test data with respect to AS 1530.4:2014

The referenced fire resistance test NI 0790 was conducted in accordance with AS 1530.4:1990, which differs slightly from AS 1530.4:2014. These variations and their potential effect on the fire resistance performance of the referenced test specimens are discussed below.

D.1 Discussion

Furnace 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 1530.4:1990. The specified specimen heating rate in AS 1530.4:1990 is given by:

$$T_t - T_0 = 345log_{10}(8t + 1)$$

AS 1530.4:2014 specifies furnace temperature to follow the following trend:

$$T_{AS1530.4-2014} = 345log_{10}(8t + 1) + 20$$

Where:

T_t = furnace temperature at time t, in °C.

T_0 = initial furnace temperature at time t, in °C, ≥10°C and ≤ 40°C.

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

The heating regimes in AS 1530.4:1990 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 1530.4:1990 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 control accuracy of the furnace temperature in AS 1530.4:2014 and AS 1530.4:1990 are not appreciably different.

Furnace overpressure

AS 1530.4:2014 requires a minimum pressure differential of 8 Pa above the laboratory atmosphere for both vertical and horizontal specimens.

AS 1530.4:2014 requires a minimum pressure differential of 15 Pa ± 3 Pa above the laboratory atmosphere at the centre of the lowest penetration for vertical specimens, and 20 Pa ± 3 Pa at 100 mm below the soffit for horizontal specimens.

The increase in furnace overpressure is only expected to be significant if cracks or fissures have developed in the test specimen.

Performance criteria

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

- structural adequacy.
- integrity.
- insulation.

Structural adequacy

The structural adequacy criteria are not relevant to this test.

Integrity

The specimen shall be deemed to have failed regarding the service penetrations, in accordance with AS 1530.4:2014, 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.

The integrity criterion varies slightly between AS 1530.4:1990 and AS 1530.4:2014. The specimen is deemed to have failed to AS 1530.4:1990 if the specimen:

- collapses.
- develops cracks, fissures or other openings through which flames or hot gases can pass.
- sustained flaming on the non-fire side in excess of 10 seconds.

The integrity criterion in accordance with AS 1530.4:1990 is generally more stringent. Integrity failure would normally occur prior to failure in accordance with AS 1530.4:2014.

Insulation

The insulation criteria of AS 1530.4:1990 and AS 1530.4:2014 remain the same, although the location of thermocouples have been revised. These differences are not considered relevant to the performance of the proposed construction.

Application of test data to AS 1530.4:2014

In general, the furnace exposure conditions of AS 1530.4:1990 are not appreciably different to AS 1530.4:2014.

The difference in specified furnace pressures between the revisions of AS 1530.4 (1990 to 2014) are only expected to be significant if cracks or fissures have developed in the test specimen, as higher furnace overpressure has a greater tendency to force hot gases from the furnace to the non-fire side, with potentially adverse effects on both integrity and insulation performance.

Test NI 0790 records no integrity failure throughout the 127 minutes duration of the test.

Based on the above discussion, it is considered that integrity performance of the test NI 0790 can be used to assess the insulation and integrity performance of the proposed construction if subjected to a fire resistance test in accordance with AS 1530.4:2014.