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Consultant advice report

Steel purlins and beams penetrating wall separating elements

Sponsor: Trafalgar Group

Report number: FAS210378 Revision: CA2.0

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Quality management

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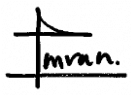
			Prepared by	**Reviewed by**	**Authorised by**
	Expiry: 31 Jan 2027	**Name**	Edward Kwok	Imran Ahamed	Omar Saad
		Signature			

Executive summary

This consultant advice report documents the findings of the investigation undertaken to determine the expected fire resistance performance of Trafalgar FyrePLUG pillows, FyreBATT, FyreFLEX sealant, TWrap insulation wrap or A1 COREX boards protected steel purlins or beams penetrating fire-rated walls – in accordance with AS 1530.4:2014.

This report was prepared at the request of Trafalgar Group specifically for the proposed construction detailed in Figure 1 to Figure 12 of this report.

The analysis in section 4 of this report found that the fire protection systems described in Figure 1 to Figure 12 would be able to mitigate the heat conduction caused by the steel penetration and provide sufficient fire protection to the penetrated separation wall element, thus allowing the separation wall to achieve integrity and insulation performance up to 120 minutes – in accordance with AS 1530.4:2014.

The variations and outcome of this report are subject to the limitations and requirements described in sections 2 and 5 of this report.

Contents

1. Introduction

This consultant advice report documents the findings of the investigation undertaken to determine the expected fire resistance performance of Trafalgar FyrePLUG pillows, FyreBATT, FyreFLEX sealant, TWrap insulation wrap or A1 COREX boards protected steel purlins or beams penetrating fire-rated walls – in accordance with AS 1530.4:2014[1].

This report was prepared at the request of Trafalgar Group The sponsor details are included in Table 1.

Table 1 Sponsor details

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

2. Limitations of this advice

- The scope of this report is limited to the assessment of steel purlins and beams penetrating fire-rated vertical separating elements protected with Trafalgar FyrePLUG pillows / FyreBATT and TWrap insulation wrap or A1 COREX boards installed as shown in the construction details given in section 3.3. The acceptable separating wall types are concrete, masonry, Speedpanel, Hebel and plasterboard walls.
- This report details the methods of construction, test conditions and assessed results that are expected if the systems were tested in accordance with AS 1530.4:2014.
- This assessment is applicable to wall systems exposed to fire from either side, but not simultaneously in accordance with the requirements of AS 1530.4:2014 where vertical elements must be exposed to heat from the direction required to resist fire exposure.
- The vertical separating elements must have an established fire resistance level (FRL) as tested or assessed by an Accredited Testing Laboratory (ATL). The assessed fire resistance performance of the penetration systems will be limited by the established FRL of the separating element.
- This report is limited to the fire protection products demonstrated in the drawings supplied by the report sponsor and provided in section 3.3.
- This report assumes fire performance on structural adequacy is not a requirement for the proposed systems. The structural adequacy performance of the steel purlins and beams is not a part of the scope of this report.
- This report is applicable to hollow and open section steel purlins and beams designed by a professional structural engineer in accordance with the requirements of AS 4100 and AS/NZS 4600.
- This report is limited to aperture sizes up to 550 mm × 550 mm or 1000 mm × 300 mm.
- The assessed steel beam/purlin penetrations at the head of the wall are only valid if the ceiling or slab has an established FRL equivalent to the FRL of the separating element.
- This report is only valid for the assessed systems and must not be used for any other purpose. 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 need to be done by an Accredited Testing Laboratory (ATL).
- The documentation that forms the basis for this report is listed in Appendix A and Appendix B.

[1] 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.

- 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.
- This assessment is based on the proposed systems being constructed under comprehensive quality control practices and following appropriate industry regulations and Australian Standards on quality of materials, design of structures, guidance on workmanship and the expert handling, placing and finishing of the products on site. These variables are beyond the control and consideration of this report.

3. Description of the specimen and variations

3.1 System description

This report addresses various construction details consisting of steel purlins and beams penetrating different types of fire-rated wall systems. Fire protection is provided by Trafalgar FyrePLUG pillows or FyreBATT installed in the aperture with either TWrap insulation wrap or A1 COREX boards installed along the steel beams for minimum 500 mm from the face of the separating element on both the exposed and unexposed sides.

Section 3.3 of this report provides the construction details of the proposed system. The expected fire performance of the system is discussed in section 4 of this report.

3.2 Referenced test and assessment data

The evaluation of the proposed construction details and variations from tested systems to determine the expected performance is based on the results of the fire tests and assessments documented in the reports summarised in Table 2. Further details of the tested systems are included in Appendix B.

Table 2 Referenced test and assessment data

Report number	Test sponsor	Test date	Testing authority
FSP 1753 Revision B	Fire Containment Pty Ltd	9 June 2016	CSIRO
FRT180392 R1.1	Trafalgar Fire	27 November 2018	Warringtonfire
FRT180323 R4.0	Trafalgar Fire	29 November 2018	Warringtonfire
FP11935-001	Fire Containment Pty Ltd	14 August 2019	BRANZ
FRT190298 R1.0	Trafalgar Fire	23 November 2020	Warringtonfire
FAS200445 R1.1	Trafalgar Group	5 May 2021 (issue date)	Warringtonfire
FAS210023 R1.3	Trafalgar Group	13 July 2022 (issue date)	Warringtonfire

3.3 Construction details

Figure 1 to Figure 12 outline the building and fire protection components of the proposed systems. The proposed systems illustrated in Figure 1 and Figure 2 use Trafalgar TWrap insulation wrap and Trafalgar FyrePLUG pillows as the main fire protection systems. The proposed systems illustrated in Figure 3 and Figure 4 also use FyrePLUG pillows installed in the aperture, but the insulation wrap is substituted with Trafalgar A1 COREX board. FyreFLEX sealant should be applied to the interface between the pillows and steel with 50 mm × 50 mm fillet.

The annular gap between the penetrating steel beam and the separating element must be maintained at minimum 20 mm to allow for unrestricted deflections of the steel beams in a fire scenario to ensure that the movement of the steel beams does not damage the separating element at the aperture and detrimentally affect the integrity of the system.

At the end of the 500 mm of protection, the opening is capped by the same fire protection material. For the TWrap construction, the ends are capped by 100 mm of TWrap to close the gaps, with 50 mm overlap at the TWrap joints – as shown in Figure 1 and Figure 2. For the A1 COREX board construction, both ends are capped with A1 COREX board and sealed with FyreFLEX sealant – as shown in Figure 3 and Figure 4.

The concept of the proposed constructions is that the Trafalgar TWrap, A1 COREX boards, FyreFLEX sealant, FyrePLUG pillows and the configuration requirements displayed in Figure 1 to Figure 5 would be sufficient to mitigate the adverse thermal effect generated by the steel penetration and thus allow the wall separating element to maintain its established fire resistance level, integrity and insulation performance.

The proposed construction shown in Figure 6 and Figure 7 consists of TWrap or A1 COREX boards protecting steel beams or purlins penetrating through the separating element at the head of the wall.

The proposed construction shown in Figure 8 to Figure 11 consists of TWrap or A1 COREX boards protecting steel beams or purlins penetrating through Trafalgar FyreBATT installed in approved wall constructions. Further details will be discussed in section 4 of this report.

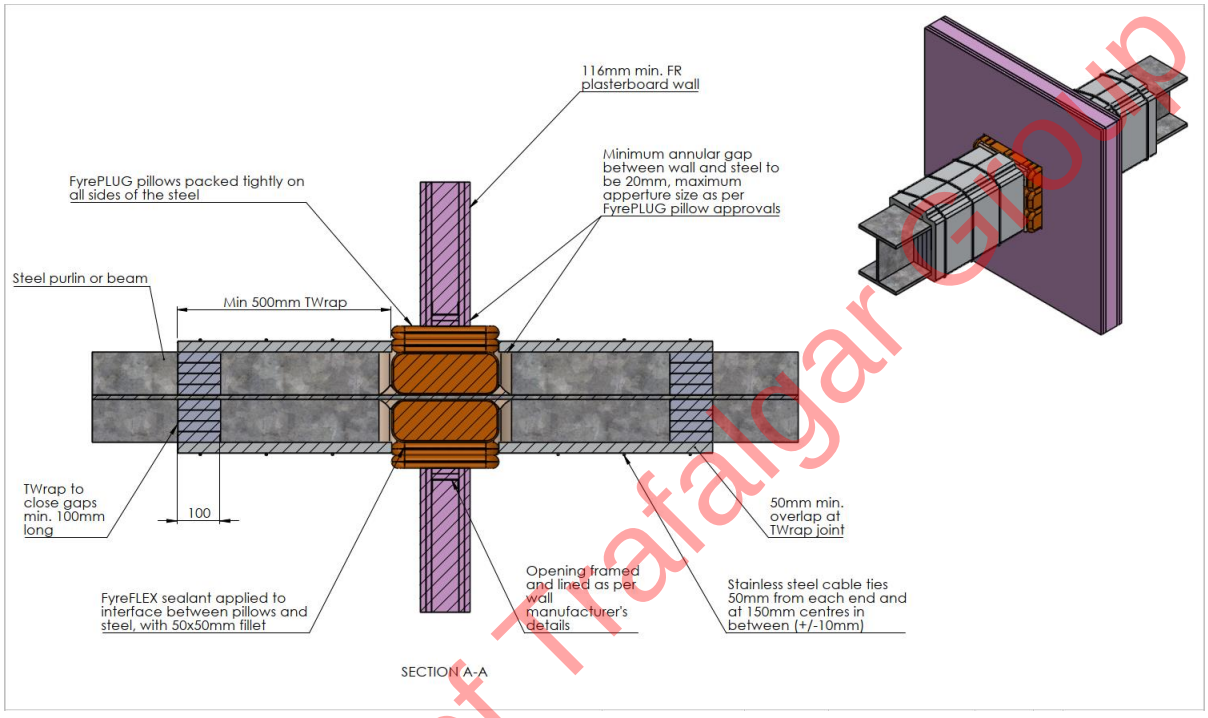


Figure 1 Proposed steel beam/purlin penetration system – detail 1

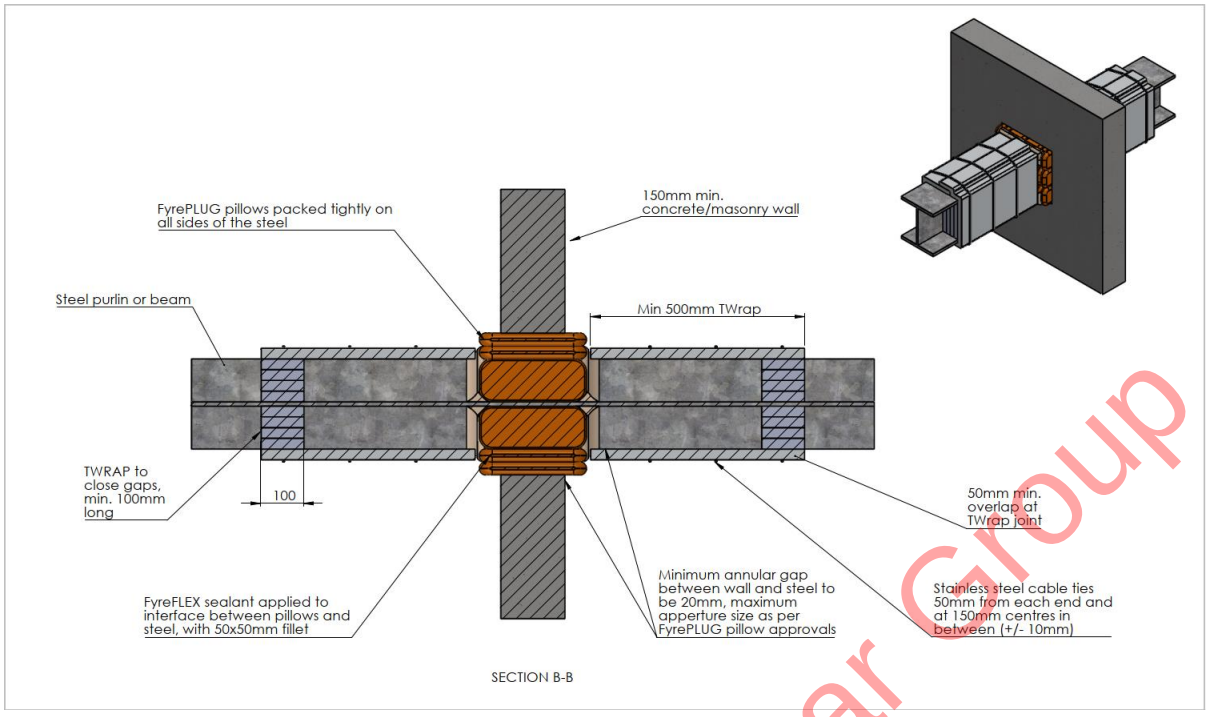


Figure 2 Proposed steel beam/purlin penetration system – detail 2

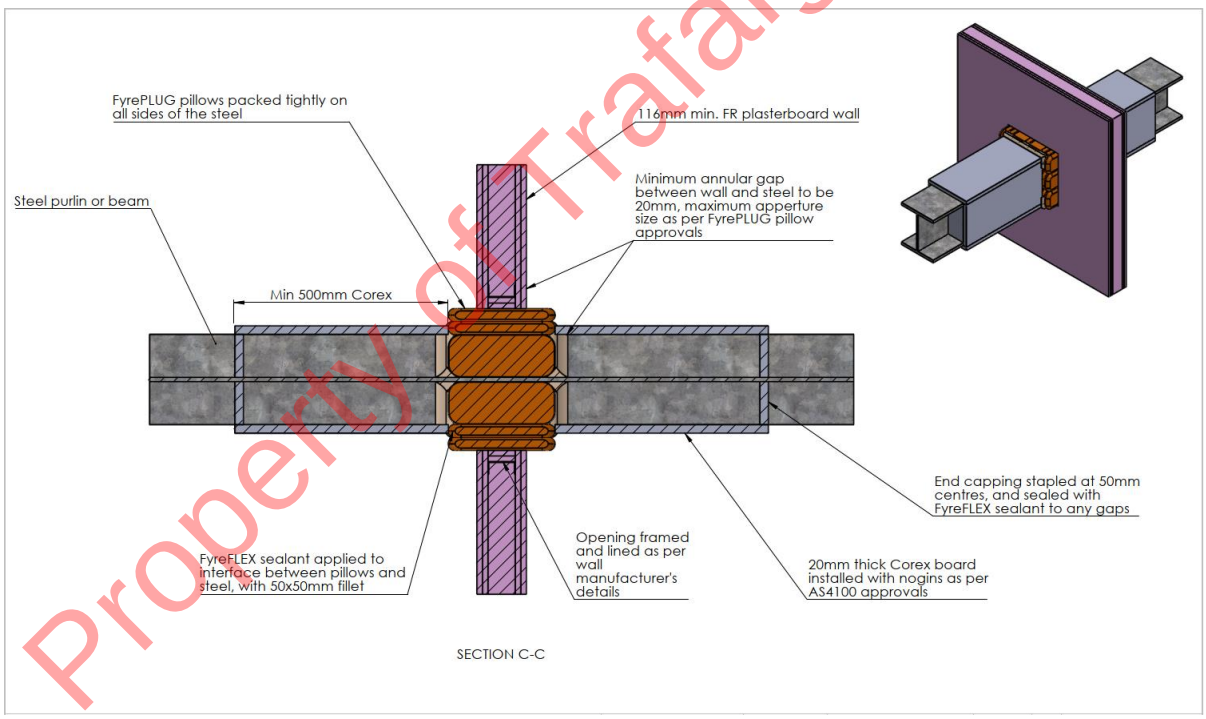


Figure 3 Proposed steel beam/purlin penetration system – detail 3

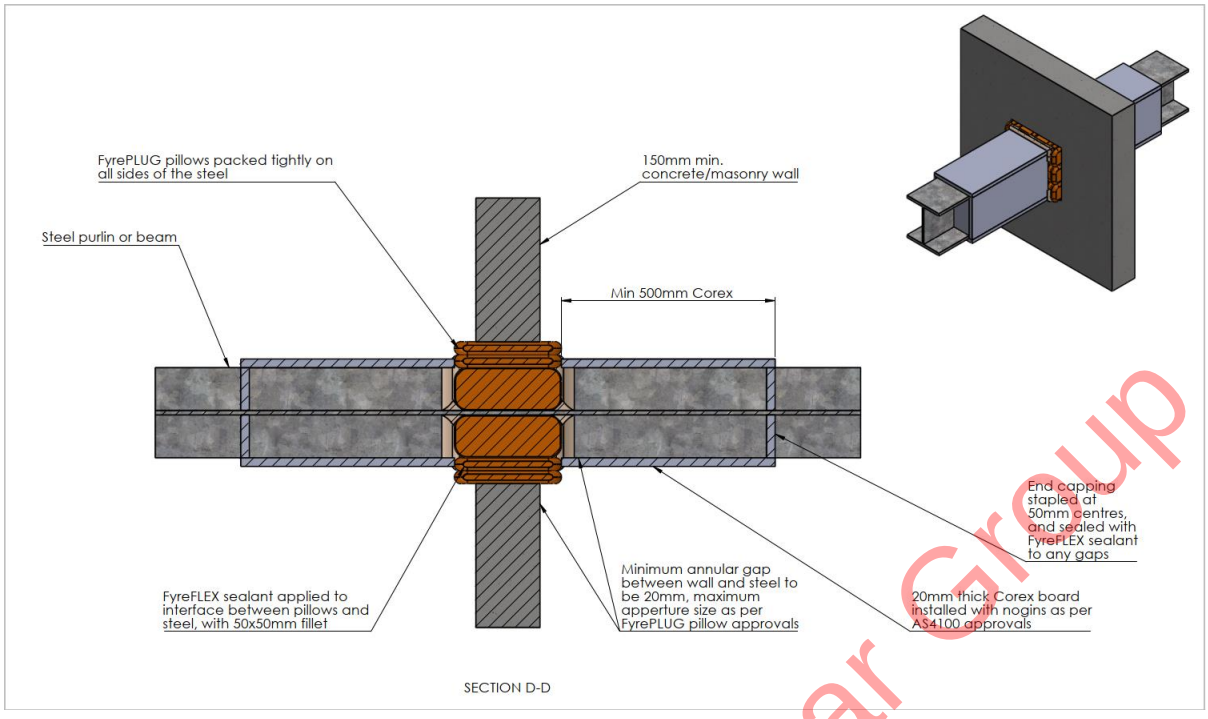


Figure 4 Proposed steel beam/purlin penetration system – detail 4

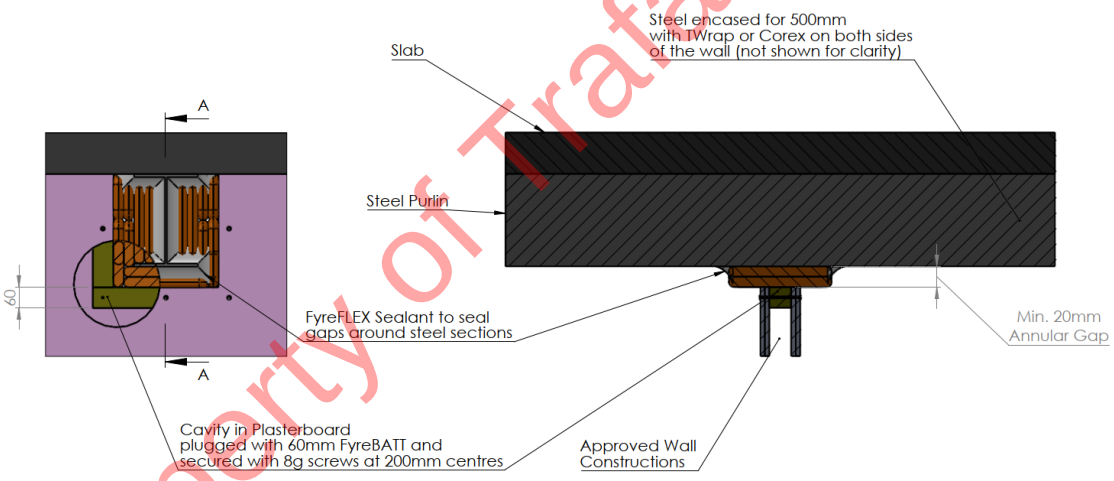


Figure 5 Proposed steel beam/purlin penetration system – detail 5

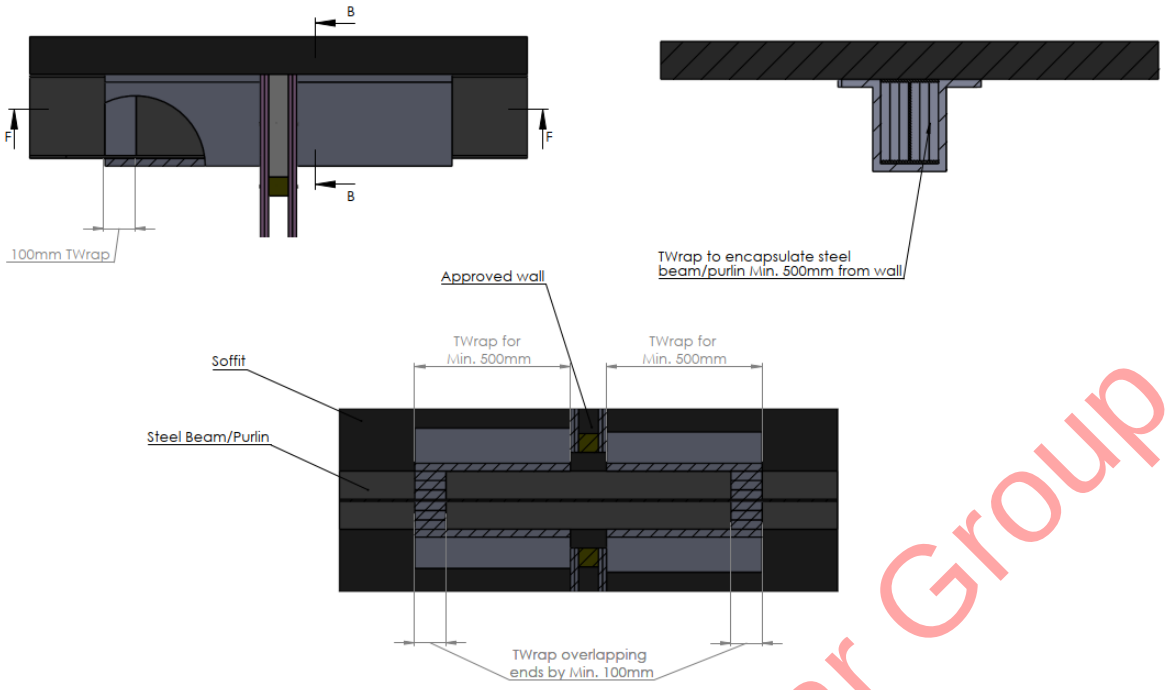


Figure 6 Proposed steel beam/purlin penetration system – detail 6

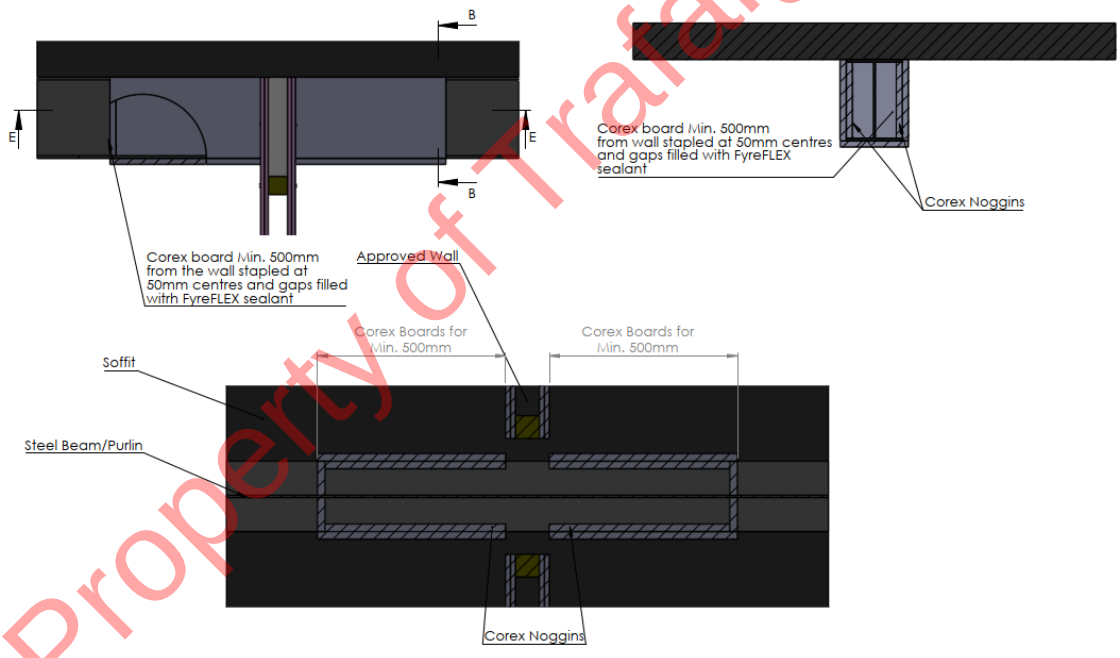


Figure 7 Proposed steel beam/purlin penetration system – detail 7

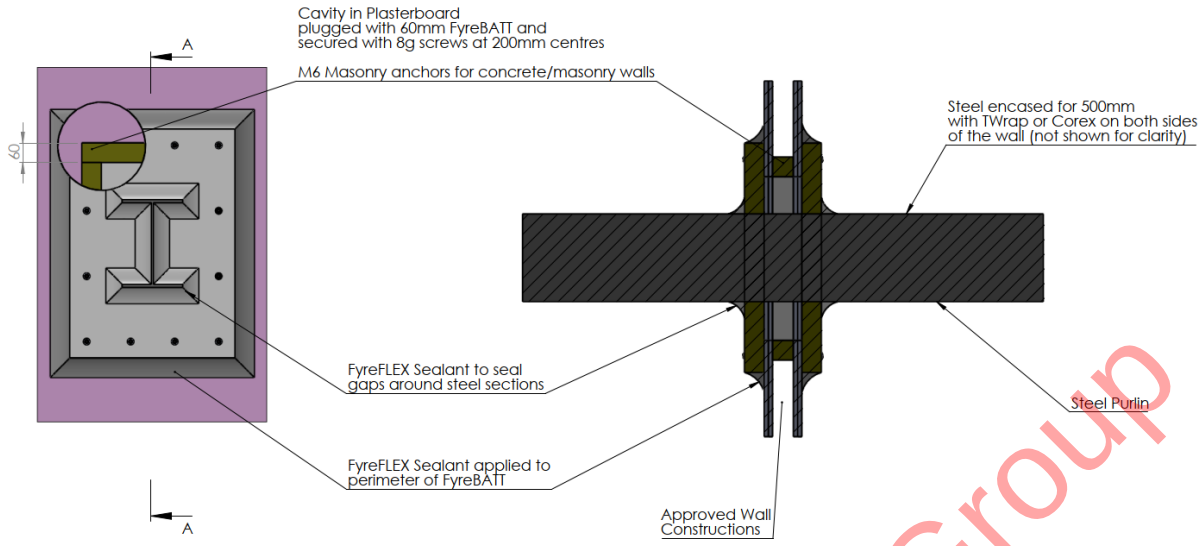


Figure 8 Proposed steel beam/purlin penetration system – detail 8

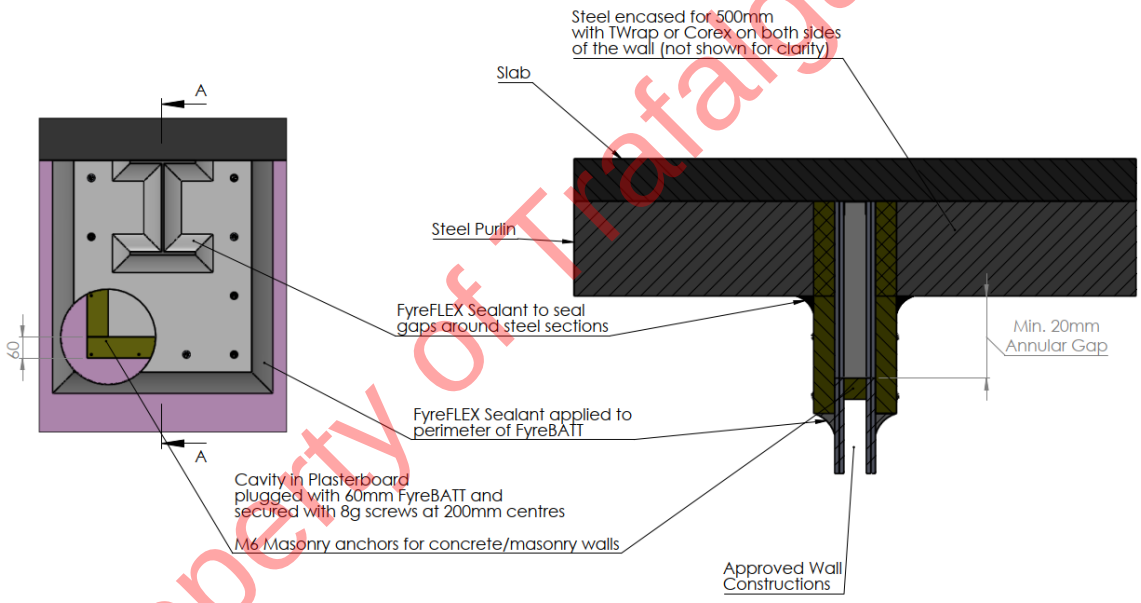


Figure 9 Proposed steel beam/purlin penetration system – detail 9

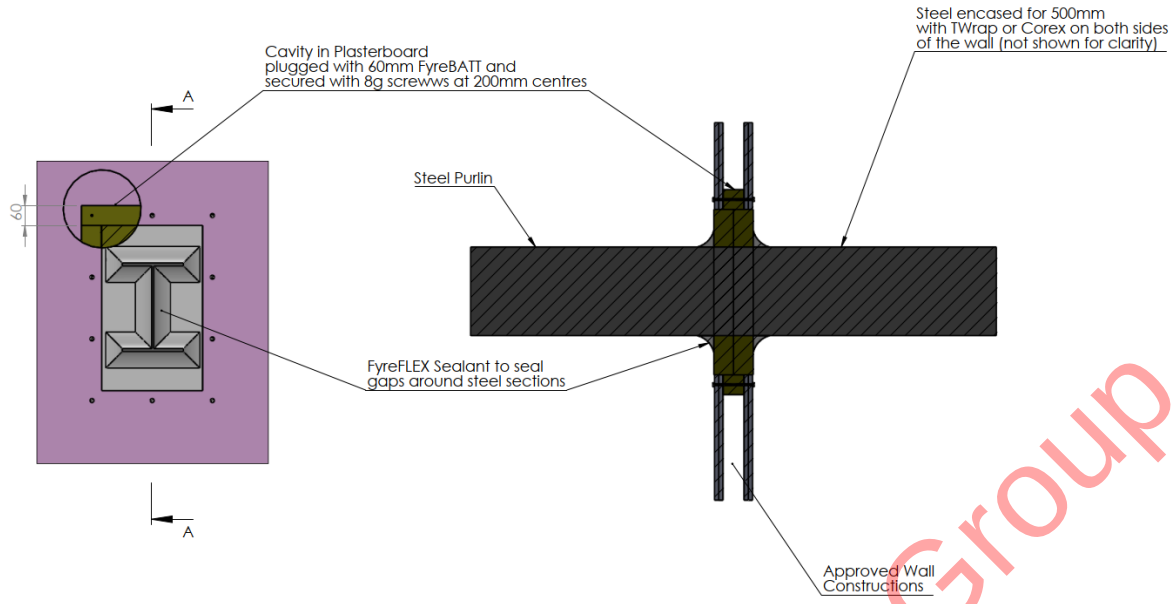


Figure 10 Proposed steel beam/purlin penetration system – detail 10

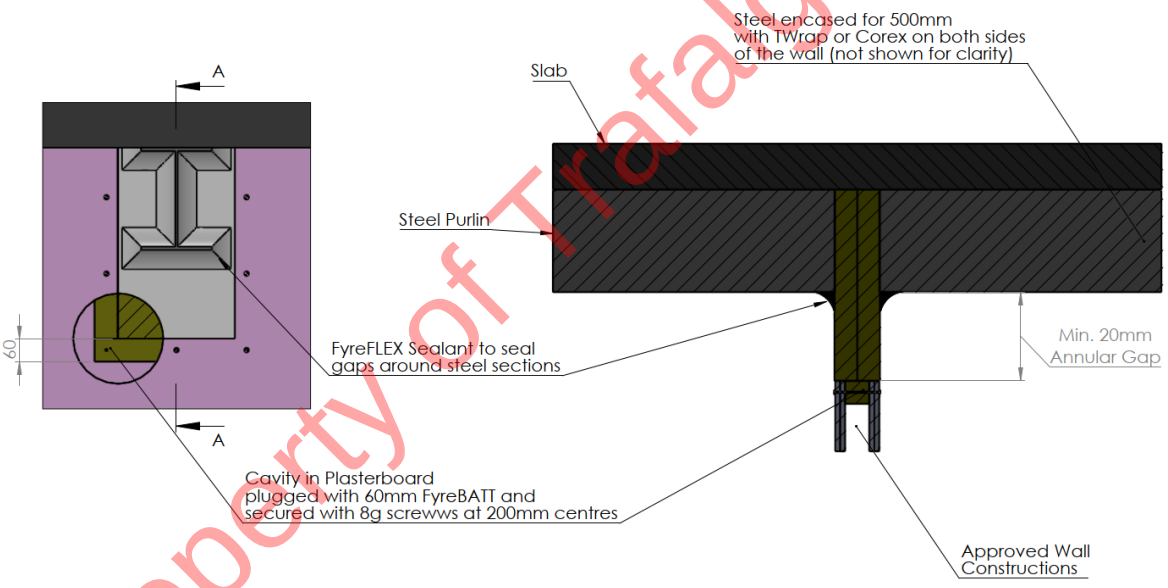


Figure 11 Proposed steel beam/purlin penetration system – detail 11

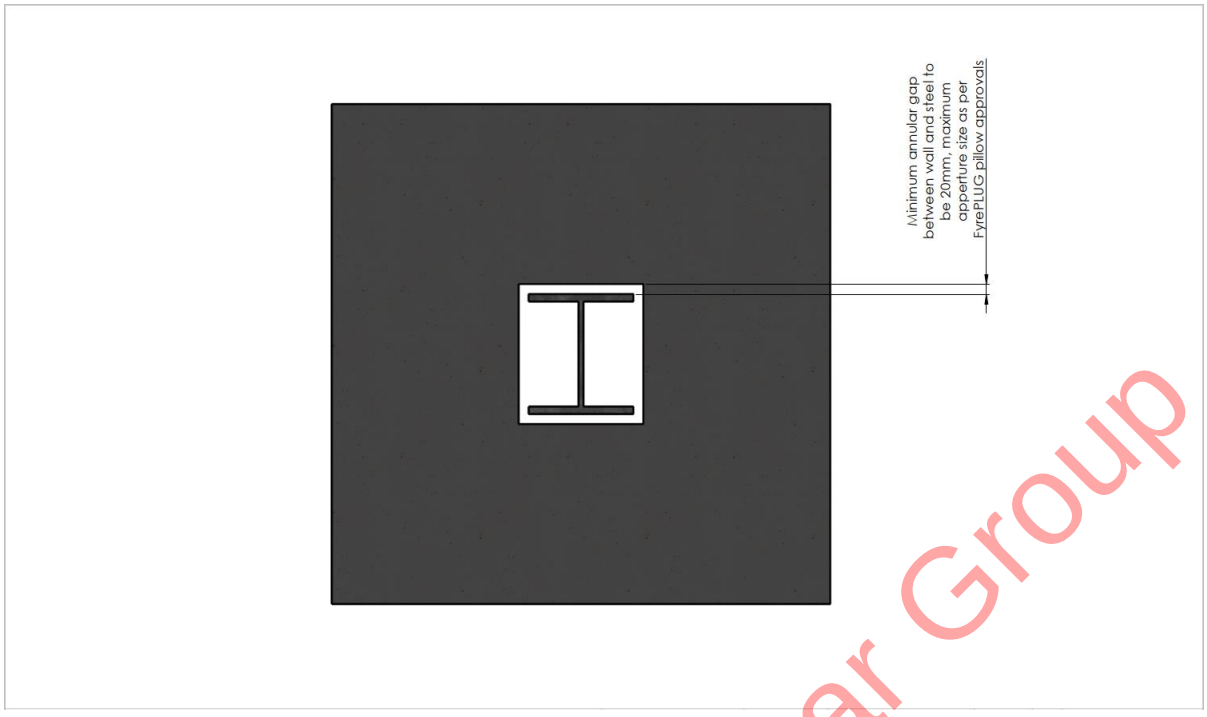


Figure 12 Proposed steel beam/purlin penetration system – minimum annular gap between wall and steel beam

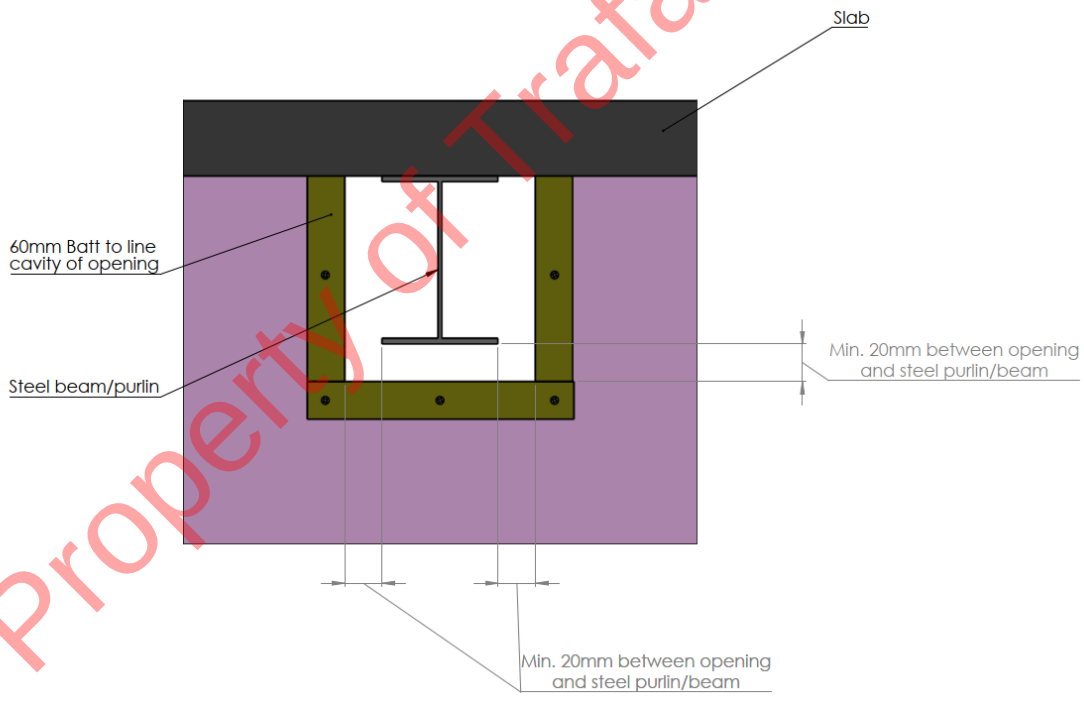


Figure 13 Proposed steel beam/purlin penetration system – cross section with FyreBATT lining

4. Performance of fire rated walls penetrated by steel purlins or beams

4.1 Description of proposed systems

The report sponsor has requested Warringtonfire to review the construction details described in Figure 1 to Figure 13 and evaluate the fire resistance performance of the proposed construction based on the supplied fire testing and assessment reports. The purpose of this report is to identify whether the fire protection systems shown in Figure 1 to Figure 13 would be sufficient to mitigate the adverse effect caused by the steel penetration and thus enable the separation wall system to maintain its established fire resistance performance.

4.2 Steel beams penetrating fire rated walls – without fire protection

It is expected that the unprotected steel beams or purlins penetrating a vertical fire separating element could lead to issues associated with the integrity and insulation performance of the system, which in turn could detrimentally affect the fire compartmentalisation provided by that separating element.

Reference is made to fire design notes FDN2[2] and FDN4[3] published by InfraBuild (formerly Liberty OneSteel) to obtain information on unprotected steel members penetrating concrete and plasterboard walls, respectively.

Based on the information provided in FDN2, a total of eight specimens were tested in a series of four tests in a pilot scale specimen. Each test specimen contained a 2 mm thick × 100 mm wide × 1200 mm long steel plate and a 20 mm × 100 mm wide × 1200 mm long steel plate. The 20 mm thick steel plate was selected to simulate the flange and web of a structural steel section, while the 2 mm thick steel plate was selected to simulate a thin purlin penetrating the wall system. Two concrete block thicknesses (120 mm and 200 mm) were selected to simulate a fire rated concrete wall. A non-fire rated PVC cable and cardboard were attached to the steel plate adjacent to the unexposed face of the wall. These objects were used to observe whether the penetration would cause ignition on the unexposed side. The test outcomes are shown in Table 3 below.

Table 3 Maximum steel temperature recorded in FDN2 at 120 minutes – 25 mm from the unexposed face of the wall

Thickness of steel plate (mm)	Tested period (minutes)	Wall thickness (mm)	Temperature recorded (°C)
20	120	120	280
20	120	200	140
2	120	120	155
2	120	200	65

FDN4 describes a similar pilot-scale test as that in FDN2, except having a fire-rated plasterboard wall as the separating element. Six specimens were tested, three penetrating a wall with a single layer of 16 mm plasterboard on each side and three penetrating a wall with two layers of 16 mm plasterboard on each side. All specimens were tested for a minimum of 120 minutes. Four plate thicknesses were selected for the tests; they are 2 mm, 8 mm, 12 mm, and 20 mm, which represent a typical steel purlin, cleat plate, web of a typical beam, and flange of a typical beam, respectively. It is important to note that the tested specimen consisted of a 10 mm gap all around the penetrated steel and aperture to prevent any damage to the separating element caused by the steel deflection.

While FDN2 concluded that the temperatures on the unexposed side were insufficient to cause any ignition on lightweight combustible materials on the non-fire side of the wall, the maximum temperature recorded for the 12 mm thick plate – above 230 °C – was greater than the insulation

[2] C. C. Goh & I. D. Bennetts, 2001, Onesteel fire design note No.2, Steel roof members – penetration of concrete fire walls, Centre for Environmental Safety and Risk Engineering, Victoria University of Technology, Australia
[3] I. D. Bennetts, K. Moinuddin & D. J. Proe, Onesteel fire design note No. 4, Structural steel members – penetration of plasterboard fire walls, Centre for Environmental Safety and Risk Engineering, Victoria University, Australia

failure threshold stipulated in AS 1530.4:2014. Therefore, although no ignition occurred, the steel penetration in FDN2 still resulted in an insulation failure.

Based on the above discussions and the outcomes of FDN2 and FDN4, it is found that steel beams penetrating flexible or rigid wall separating elements do have an adverse impact on the overall fire resistance performance of the wall system. It was found that while the temperatures on the unexposed side of unprotected beams may be high enough to cause an insulation failure in accordance with the insulation criteria specified in AS 1530.4:2014, the temperatures reduce drastically from those measured on the exposed side as the heat is conducted across the separating element.

With the above information and conclusions drawn from FDN2 and FDN4, the proposed constructions demonstrated in section 3.3 of this report – which consist of additional fire protection components compared to the systems tested in FDN2 and FDN4 – are expected to provide the fire resistance performance needed.

Furthermore, FDN2 notes that since steel temperatures are lower closest to the wall due to the gradient of heat conduction along the beam to the cooler unexposed side, most of the inelastic deformation is expected to occur away from the separating element and aperture. This means that the integrity of the wall is not expected to be detrimentally affected. However, FDN2 also recommends that gaps around the steel member at the aperture be sealed with a fire-stopping material. Additionally, as some deformations in the steel beam are still expected at the aperture and since the tests conducted for FDN2 and FDN4 were pilot scale tests which do not demonstrate the deflections of a full-sized separating element, the annular gap must be maintained at a minimum 20 mm between the steel member and the aperture.

4.3 Steel beams penetrating fire rated walls – with proposed fire protection

As shown in Figure 1 to Figure 5 and Figure 12, the proposed constructions uses Trafalgar FyrePLUG pillows installed in the aperture to maintain the integrity performance of the penetration system. Insulation performance is proposed to be maintained with TWrap insulation wrap or A1 COREX boards installed along the steel purlin or beam for a length of minimum 500 mm from both sides of the separating element. FyreFLEX sealant is proposed to be applied at the interface between pillows and steel and at the end capping of A1 COREX boards.

The integrity performance of FyrePLUG pillows in different types of separating elements is discussed in section 4.3.1. The application of having the protected beam penetrating the separating element at the head of the wall is discussed in section 4.3.4.

4.3.1 Services penetrating Trafalgar FyrePLUG pillows in vertical separating elements

Plasterboard walls

The referenced test FP111935-001 consisted of a nominally 2200 mm high × 1000 mm wide × 116 mm thick steel stud wall lined with two layers of 13 mm thick USG Boral firestop plasterboard on each face. The wall was provided with two 550 mm × 550 mm apertures and fitted with several pipe and cable 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 penetration. Any gaps that occurred on the services were protected with FyreFLEX sealant, including the service pipe circumference and FyrePLUG pillows. The penetration services that are relevant to the proposed construction are penetration no. 4 to no. 7 where Trafalgar FyrePLUG was used as part of the primary fire protection, with a 50 mm × 50 mm FyreFLEX sealant fillet applied around the cable tray and cables onto the FyrePLUG pillows on both sides for penetration no. 4, and a 30 mm × 30 mm fillet around the bundles and onto the FyrePLUG pillows for penetration no. 7. The penetration details and test outcomes are shown in Table 4 below. FyreFLEX sealant was applied between the service and the FyrePLUG pillows.

Table 4 FP11935-001 penetration systems

Penetration No.	Penetration details	Integrity (mm)	Insulation (mm)	FRL
4	Trafalgar FyrePLUG and TWrap on power cable	Failure at 119 minutes	Failure at 150 minutes	-/90/120
5	Trafalgar FyrePLUG and TWrap on 100 mm diameter copper pipe	No failure at 180 minutes	No failure at 180 minutes	-/120/120
6	Trafalgar FyrePLUG and FyreFLEX on cable bundle	No failure at 180 minutes	Failure at 159 minutes	-/120/120
7	Trafalgar FyrePLUG and FyreFLEX on CAT 6 Data cable bundle	No failure at 180 minutes	Failure at 173 minutes	-/120/120

The test was conducted for 180 minutes. However, the results have been derated to match the established FRL of the separating element.

As shown in Table 4 above, these penetration systems displayed no integrity failure at 180 minutes except for penetration no. 4. 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 the 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 oriented pillows onto horizontal pillows at the bottom corner of the aperture adjacent to the specimen. Hot gases were escaping via the gap opening, resulting in integrity failure just under 120 minutes.

The FyrePLUG pillows in all other areas were neatly packed with minimal gaps. It is evident that if the pillows were better packed, 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 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 integrity and insulation performance for 180 minutes. The achieved results of the sealing system are expected to be maintained when protecting copper, brass, or ferrous metal pipes.

Service penetration nos. 6 and 7 consisted of a bundle of TPS cables and a bundle of CAT6 data cables, respectively. Both services maintained integrity performance for the whole 180 minute duration of the test.

Based on the discussion above, it is expected that installing Trafalgar FyrePLUG pillows will allow the proposed system to maintain integrity performance for up to 120 minutes – if fitted appropriately – given that the separating element has an established FRL of -/120/120 by others.

Speedpanel walls

In test report FRT180323, the test assembly consisted of a 78 mm thick Speedpanel wall system penetrated by 18 services across 15 systems. Trafalgar FyreFLEX or FyrePEX HP sealant were used as local fire stopping protection for each penetration.

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, where the interface between the cable bundle and pillows was sealed with a nominal 30 mm × 30 mm FyrePEX or FyreFLEX sealant fillet on both the exposed and unexposed sides of the separating element.

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, i.e., 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.

Based on the discussion above, it is considered that the integrity performance of Speedpanel walls is expected to be maintained for up to 120 minutes when the aperture is filled with Trafalgar FyrePLUG pillows in accordance with AS 1530.4:2014.

Hebel walls

The Hebel AAC wall consists of a lightweight cement based core mixture, which is similar to Speedpanel walls. Therefore, it is expected that the Hebel AAC wall would display a similar temperature profile as the Speedpanel when heated.

As discussed in section 4.3.1, the integrity performance of the separating element is expected to be maintained if the Trafalgar FyrePLUG pillows are installed correctly into the aperture. Therefore, with FyrePLUG pillows installed into the aperture, the proposed construction would be able to achieve 90 minutes of integrity performance in Hebel walls.

Concrete and masonry wall

In accordance with the provisions in AS 1530.4:2014, the results of a test with a plasterboard lined frame wall system would be applicable to similar penetration and sealing systems installed in a concrete or masonry wall of the same or greater thickness. Based on the information provided in AS 1530.4:2014, it is expected that the FyrePLUG pillows would be able to provide the same integrity performance as the concrete and masonry separation wall elements if the pillows are correctly installed.

Summary of integrity performance

As discussed in section 4.3.1, it is considered that the integrity performance of a separating element with metallic members penetrating through an aperture installed with Trafalgar FyrePLUG pillows and Trafalgar FyreFLEX sealant is expected to be maintained for the established integrity performance of the separating element. Furthermore, the use of FyrePLUG pillows and FyreFLEX sealant has demonstrated the ability to maintain integrity performance for up to 120 minutes in all considered tests. Therefore, it is considered that when steel beams and purlins penetrating any separating element are protected with FyrePLUG pillows and FyreFLEX sealant at the aperture, the proposed system is expected to achieve the established integrity performance of the separating element for up to 120 minutes.

The FyreFLEX sealant must be applied at the interface between the steel beam or purlin and the FyrePLUG pillow with a fillet of 50 mm × 50 mm, as tested. The 100 mm TWrap and A1 COREX board end cap should be installed as detailed in Figure 1 to Figure 5 and Figure 12 to prevent the passage of flaming along the beam in the case of a gap formation in the pillows and high steel temperature on the separating element.

4.3.2 Steel purlins and beams protected with Trafalgar TWrap

As discussed earlier in this report, the adverse effect caused by steel penetration is associated with the heat conduction of the steel substrate. The proposed constructions illustrated in this report use Trafalgar TWrap or Trafalgar COREX board as the main fire protection elements to minimise the effect of thermal conduction caused by the steel element. Comparable results can be found in FRT180392 R1.1, FRT190298 R1.0 and FSP 1753 Revision B, where steel pipe penetrations and Trafalgar TWrap were used in plasterboard walls, Speedpanel walls and Hebel walls, respectively.

Table 5 Various fire test details

Reference test	System / specimen	Service penetration	Dimensions	Estimated section factor (HP/A)	Coverage of Trafalgar TWrap
FRT180392 R1.1	F	Steel pipe	Outer diameter (OD): 114.64 mm Inner diameter (ID): 105.48 mm Thickness: 4.58 mm	227.4 m^{-1}	400 mm both sides
FRT190298 R1.0	A	Steel pipe	Outer diameter (OD): 114 mm Inner diameter (ID): 108 mm Thickness: 3.1 mm	331.6 m^{-1}	450 mm on the unexposed side and 300 mm on the exposed side
FSP 1753 Revision B	1	Steel sprinkler pipe	Outer diameter (OD): 48 mm Thickness: 3.5 mm	309 m^{-1}	300 mm both sides

In all considered tests, at 120 minutes, the maximum temperature rise on the service 25 mm away from the TWrap was less than 180 °C. This suggests that with a minimum of around 450 mm of TWrap on both the exposed and unexposed sides, the temperature on the service itself can be expected to be less than the insulation failure threshold stipulated in AS 1530.4:2014.

While the 500 mm coverage of Trafalgar TWrap in the proposed construction is greater than the above tested systems in FRT180392 R1.1, FRT190298 R1.0 and FSP 1753 Revision B, it is expected that the temperatures measured on the unexposed side of the proposed steel purlin or beam penetrations would be less than the insulation threshold in accordance with AS 1530.4:2014 and it is expected to achieve an insulation performance of 120 minutes.

4.3.3 Steel purlins and beams protected with Trafalgar A1 COREX board

The proposed constructions demonstrated in Figure 3 and Figure 4 utilise the Trafalgar A1 COREX boards instead of the Trafalgar TWrap. The boards extend for a minimum distance of 500 mm to the steel penetration on both the exposed and unexposed sides of the system. Both ends of the steel will be capped and protected by a combination of Trafalgar A1 COREX board and Trafalgar FyreFLEX sealant.

According to the ASFP Technical Guidance Document 8 (TGD 8), Advisory Note 21[4] states that “if there is no evidence to support the omission of the coat back then a figure of 500 mm as stated in ASFP TGD 8 ‘Code of practice for junctions between different fire protection systems’ when applied to load bearing structural steel elements should be assumed as a conservative”. Based on this information, it is considered the minimum 500 mm COREX board for the proposed construction is sufficient to limit the heat transfer to the separation element, thus preventing fire resistance performance degradation on the separation wall element caused by the steel penetration.

4.3.4 Trafalgar TWrap or A1 COREX board protected steel beam/purlin penetrating vertical separating elements at the head of the wall

The fire resistance performance of FyrePLUG Pillows installed at mid-height of the vertical separating elements was addressed in previous sections. It is proposed to install the penetration at the head of the separating elements instead of mid-height as shown in Figure 5.

When a steel purlin is positioned at the head of the wall – where the top flange of the steel beam/purlin is in contact with the bottom side of the ceiling or slab – the top side of the steel beam/purlin is expected to be protected by the ceiling or slab. Considering that the fire performance of the FyrePLUG pillows would remain the same on the two sides and the bottom face of the steel purlin, the proposed construction shown in Figure 5 is considered capable of maintaining a FRL up to

[4] Association for Specialist Fire Protection, 2010, TGD 8- Code of practice for junctions between different fire protection systems when applied to load bearing structural steel elements., Association for Specialist Fire Protection, UK.

-/120/120 – given that the ceiling or slab has an established FRL that is identical to the separating wall.

The above discussion is applicable to the proposed constructions shown in Figure 6, Figure 7, Figure 9 and Figure 11, where the fire rated ceiling or slab is expected to provide sufficient insulation to the top side of the steel purlin – given that the ceiling or slab have an established FRL that is identical to the separating wall. The validity of construction details in Figure 9 and Figure 11 is discussed in section 4.3.5.

It must be noted that the fire performance of the ceiling or slab must have an established FRL assigned by an accredited testing laboratory for at least the required period of FRL as the purlin/beam penetration. For instance, where the ceiling or slab in contact with the steel beam/purlin is non-fire rated, the discussion in this consultant advice report is invalid.

4.3.5 Trafalgar TWrap or A1 COREX board protected steel penetrating Trafalgar FyreBATT system installed to plasterboard wall and rigid wall

The assessment report FAS210023 assessed the fire performance of Trafalgar FyreBATT in various separating elements. The report demonstrates that Trafalgar FyreBATT is compatible with various separating wall elements such as concrete walls, masonry walls, double layer plasterboard walls, Speedpanel walls, Hebel walls and AAC panel walls. The assessment report also demonstrates that Trafalgar FyreBATT can be installed with either the surface mounted or friction fitted methodology, and it is compatible with various service penetrations, including steel penetration.

Based on the information provided in the assessment report, Trafalgar FyreBATT achieved the outcomes as shown in Table 6 when penetrated by galvanised steel pipe.

Table 6 FAS210023 – Assessed FRL of service protected with double layers FyreBATT in walls

Reference test	System reference	Service penetration	Dimensions	Estimated section factor (HP/A)	Coverage of Trafalgar TWrap	FRL
FRT200397 R1.2	TPD31	Galvanised steel pipe	150 mm diameter × 4.9 mm thick	211 m^{-1}	450 mm both sides	-/240/90
	TPD32				600 mm both sides	-/240/120

The above assessment outcome shows that for steel penetration with a section factor of 211 m^{-1}, having 450 mm long Trafalgar TWrap on both sides of the wall would allow the system to maintain integrity performance up to 240 minutes.

Provided that the FyreBATT is capable of maintaining the integrity performance at the purlin/beam penetration interface, it is considered that having 500 mm long Trafalgar TWrap on both the exposed and unexposed sides of the wall would be sufficient to maintain insulation performance up to 120 minutes as discussed in section 4.3.2. Similar insulation performance can be expected to be achieved if the purlin/beam is protected with A1 COREX boards as discussed in section 4.3.3.

Based on the outcome of assessment report FAS210023, the analysis in section 4.3.4 and the discussion above, it is considered that the proposed construction shown in Figure 8 to Figure 11 is capable of maintaining the integrity and insulation performance of the separating element for up to 120 minutes.

4.4 Conclusion

It is considered that the Trafalgar fire protection components described in the construction details shown in Figure 1 to Figure 13 would be able to mitigate the adverse effect created by the steel penetration and thus allow the separating wall to maintain its established fire performance.

It is the opinion of Warringtonfire that wall systems with steel beam or purlin penetrations – as detailed in Figure 1 to Figure 13 – are capable of mitigating the thermal conduction effect caused by the steel penetration, as long as all fire protection systems are correctly installed as per the manufacturer's guidelines or relevant fire testing or assessment reports. Therefore, the systems are considered capable of maintaining integrity and insulation performance up to 120 minutes – in accordance with AS 1530.4:2014.

5. Validity

Warringtonfire does not endorse the tested or assessed product in any way. The conclusions of this advice may be used to directly assess fire resistance, but it should be recognised that a single test method will not provide a full assessment of fire resistance 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 advice is based on the information and experience available at the time of preparation. The published procedures for the conduct of tests and the assessment of the test results are subject to constant review and improvement.

This advice represents our opinion about the performance of the proposed systems expected to be demonstrated on a test in general accordance with AS 1530.4:2014, based on the evidence referred to in this report. This advice is provided to Trafalgar Group for their own specific purposes.

Appendix A Drawings and additional information

Table 7 Details of drawings

Drawing title	Dwg no	Date	Drawn by	Provided by
Steel beam penetrations – SBP 1	1	10 December 2021	MP	Trafalgar Group
Steel beam penetrations – SBP 2	2			
Steel beam penetrations – SBP 3	3			
Steel beam penetrations – SBP 4	4			
Steel beam penetrations – Annular Gap	5			
FyrePLUG Pillows (Soffit)	1	4 August 2022	DP	
FyreBATT Face Fixed (Soffit)	2			
FyreBATT Face Fixed	3			
FyreBATT Friction Fit (Soffit)	4			
FyreBATT Friction Fit	5			
TWrap	6			
Corex	7			
FyreBATT Lining	8			

Appendix B Summary of supporting test data

B.1 Test report – FSP 1753 Revision B

Table 8 Information about test report

Item	Information about test report
Report sponsor	Fire Containment Pty Ltd
Test laboratory	CSIRO, 14 Julius Avenue, North Ryde, NSW 2113
Test date	The fire resistance test was done on 9 June 2016.
Test standards	The test was done in accordance with AS 1530.4:2014.
Variation to test standards	None
General description of tested specimen	The specimen comprised five penetration services to a 75 mm thick Hebel autoclaved aerated concrete (ACC) wall system protected by a combination of Trafalgar Fire passive fire stopping systems. The fire protection products include Trafalgar Fyrebox Slabmount, Trafalgar Fyrechoke Micro Collars and FyreFLEX Sealant, Trafalgar FyrePex Sealant, Trafalgar FyreFLEX Sealant and TWrap insulation and Trafalgar SuperStopper 125 mm × 125 mm. The service penetration 1 is relevant for this assessment.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:2014

The test specimen achieved the following results – see Table 9.

Table 9 Results summary for this test report

Specimen	Penetration details	Criteria	Results	FRL
1	Trafalgar Fyrebox Slabmount with Maxilite and TWrap protecting service penetrations	Structural adequacy	Not applicable	-/90/60
		Integrity	No failure at 121 minutes	
		Insulation	Failure at 64 minutes	

B.2 Test report – FRT180392 R1.1

Table 10 Information about test report

Item	Information about test report
Report sponsor	Trafalgar Fire
Test laboratory	Warringtonfire, 409-411 Hammond Road, Dandenong, Victoria 3175, Australia.
Test date	The fire resistance test was done on 27 November 2018.
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 wall system consisted of two layers of 13 mm thick CSR Fyrchek fire rated plasterboard fixed onto both sides of a 64 mm 0.5 BMT steel stud to construct a wall at 116 mm total thickness with studs located at nominal 600 mm centres with a vertical joint between the plasterboard sheets. Ten varying service penetrations protected by Trafalgar FyreFLEX™ Sealant, Trafalgar TWrap, Trafalgar FyreSAFE FR Batts, and Trafalgar FyreBOX™ Mini penetrated the wall system. The service penetration F is relevant for this assessment.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:2014

The test specimen achieved the following results – see Table 11.

Table 11 Results summary for this test report

System	Penetration details	Criteria	Results	FRL
F	NB100 steel pipe protruded nominally 600 mm on the exposed and 600 mm on the unexposed sides of the separating element. The pipe was capped on the exposed side with steel pipe capping. FyreFLEX™ Sealant was applied to the annular gaps between the service and the separating element to a nominal 15 mm fillet on both the exposed and unexposed sides to the depth of the CSR Fyrchek Plasterboard. 300 mm and 100 mm long strips of TWrap were wrapped around the service on both the exposed and unexposed side to form a nominal 400 mm length of TWrap with a 50 mm overlap. The TWrap was held in place with aluminium reinforced tape across the overlap at nominal 200 mm centres. The service support was enclosed in the TWrap.	Structural adequacy	Not applicable	-/120/120
		Integrity	No failure at 130 minutes	
		Insulation	No failure at 130 minutes	

B.3 Test report – FRT180323 R4.0

Table 12 Information about test report

Item	Information about test report
Report sponsor	Trafalgar Group
Test laboratory	Warringtonfire, 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 AS 1530.4:2014
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 13 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 were packed around the services and sealed together with FyreFLEX sealant. A 300 mm section of the TWrap wrapped around the pipe on the unexposed side and the 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	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,	Structural adequacy	Not applicable	
			Integrity	No failure at 121 minutes	
			Insulation	Failure at 87 minutes	
			Integrity	No failure at 121 minutes	

System	Penetration details	Criteria	Results	FRL
	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 113 minutes	

B.4 Test report – FP11935-001

Table 14 Information about test report

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 done on 14 August 2019.
Test standards	The test was done in accordance with AS 1530.4:2014.
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. The service penetration 4, 5, 6 and 7 are relevant for this assessment
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:2014.

The test specimen achieved the following results – see Table 15.

Table 15 Results summary for this test report

Specimen	Penetration details	Criteria	Results	FRL
4	Cable tray with Appendix D1 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. FyrePLUG 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).	Integrity	Failure at 119 minutes	-/90/120
		Insulation	Failure at 150 minutes	
5	100 mm OD copper pipe mounted on an external frame on the unexposed face and FyrePLUG pillows packed into the aperture until filled. FyreFLEX sealant applied around the 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).	Integrity	No failure at 180 minutes	-/120/120
		Insulation	No failure at 180 minutes	
6	Bundle of 10 TPS PVC insulated cables laid on pre-packed FyrePLUG pillows and the aperture filled with FyrePLUG pillows packed above the cable bundles. FyreFLEX sealant applied to the cable bundles and FyrePLUG pillows.	Integrity	No failure at 180 minutes	-/120/120
		Insulation	Failure at 159 minutes	
7	Bundles of 20 CAT6 PVC insulated data cables laid on pre-packed FyrePLUG pillows and the aperture filled with FyrePLUG pillows packed above the cable bundles. FyreFLEX sealant applied to the cable bundles and FyrePLUG pillows.	Integrity	No failure at 180 minutes	-/120/120
		Insulation	Failure at 173 minutes	

B.5 Test report – FRT190298 R1.0

Table 16 Information about test report

Item	Information about test report
Report sponsor	Trafalgar Fire
Test laboratory	Warringtonfire, 409-411 Hammond Road, Dandenong, Victoria 3175, Australia.
Test date	The fire resistance test was done on 23 November 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 wall system is a 78 mm thick speed panel wall system with an access panel and two penetration systems. The three systems were protected by Trafalgar TWrap, Trafalgar FyreFLEX sealant, Trafalgar Fyrchoke collar and Trafalgar Maxilite board. The service penetration A is relevant for this assessment.
Instrumentation	The test report states that the instrumentation was in accordance with AS 1530.4:2014.

The test specimen achieved the following results – see Table 17.

Table 17 Results summary for this test report

System	Penetration details	Criteria	Results	FRL
A	DN100 galvanised steel pipe protruded nominally 500 mm on the exposed side and nominally 750 mm on the unexposed side from the separating element. The pipe was capped with a steel end cap welded on the exposed side. The pipe was sealed with FyreFLEXsealant from both sides of the wall to the full depth of the Speedpanel panel and finished with a 30 mm × 30 mm fillet. Two 300 mm wide strips of TWrap were applied longitudinally along the unexposed face of the pipe to a length of 450 mm with nominal 50 mm overlap where the TWraps overlapped. TWrap was held in place with steel cable ties at 100 mm centres, starting 50 mm from the wall. On the exposed face, a 300 mm strip was wrapped around the pipe and secured with three steel cable ties at 100 mm centres leaving 200 mm of exposed steel pipe.	Structural adequacy	Not applicable	-/120/90
		Integrity	No failure at 121 minutes	
		Insulation	Failure at 113 minutes	

B.6 Assessment report – FAS200445 R1.1

Table 18 Information about assessment report

Item	Information about assessment report
Report sponsor	Trafalgar Group
Test laboratory	Warringtonfire
Issue date	The fire assessment report was issued on 5 May 2021.
Standard	The assessment was carried out in accordance with AS 4100:1998 (R2016) Incorporating Amendment 1 and AS 1530.4:2014.
General description	The fire assessment report provides information on the required Trafalgar A1 COREX board thickness below the limiting steel temperature, depending on the steel sections and desired period of structural adequacy.

B.7 Assessment report – FAS210023 R1.3

Table 19 Information about assessment report

Item	Information about assessment report
Report sponsor	Trafalgar Group
Test laboratory	Warringtonfire
Issue date	The fire assessment report was issued on 13 July 2022.
Standard	The assessment was carried out in accordance with AS 1530.4:2014 and AS 4072.1:2005.
General description	The fire assessment report assesses the fire resistance performance of Trafalgar FyreBATT installed on various separating wall types with different installation methodologies.

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