

Fire Assessment Report

AR23108

**Likely fire resistance performance of
FIRESTOP DUCTWRAP-38 for internal and
external fire protection of a rectangular or
circular duct**

Issued to: Firestop Centre Ltd

Report Date: 18/02/2025

Revision: 3

Valid till: 09/08/2028



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1.1 Document Revision Schedule

| Revision # | Date | Description |
|--------------------------------|------------------------------|--|
| 1 | 14/05/2024 | Initial issue for Client review |
| Prepared by: Daniel De Jong | Reviewed by: Alex Kokorin | Authorised by: Andrew Bain |
| 2 | 22/05/2024 | Typographical errors amended |
| Prepared by: Daniel De Jong | Reviewed by: Alex Kokorin | Authorised by: Andrew Bain |
| 3 | 18/02/2025 | Additional test reports are amended, layout changed, drawings and descriptions are amended for clarity |

1.2 Signatories

| Report | Name | Signature | Date |
|----------------------------|--------------|--|------------|
| Prepared by: | Alex Kokorin |  | 18/02/2025 |
| Revised and authorised by: | Andrew Bain |  | 18/02/2025 |

1.3 Contact Details

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2. Introduction

The objective of the report is to assess the likely fire resistance performance of FIRESTOP DUCT WRAP-38 for external and internal fire exposure of rectangular and circular ducts if tested to AS1530.4-2014 in conjunction with AS4072.1 -2005 for the protection of penetrations through vertical and horizontal fire-rated separating elements of construction.

The following variations were considered in the assessment:

- Different orientations and types of fire separations (walls and floors)
- Penetration details of ducts penetrating through various separating elements
- Size of ducts, rectangular and circular
- Required wrap thickness and fixing details for internally exposed ducts
- Performance of externally exposed ducts
- Alternative sealants
- Protection of penetrations and Support systems
- Additional access panels
- 2- and 3- side accessible ducts

3. Test Reports

The following test reports were considered in the assessment:

Table 1: Relevant Test Reports

| Test report # | Duct size | Shape | Duct Orientation | Exposure |
|---------------|------------|-------------|------------------|----------|
| PF23004 | 800x800mm | Square | Horizontal | Internal |
| PF23082 | 1800x400mm | Rectangular | Horizontal | Internal |
| PF23083 | 1000x500mm | Rectangular | Horizontal | Internal |
| PF23095 | 800x800mm | Square | Vertical | Internal |
| PF23110 | 800mm | Circular | Horizontal | Internal |
| PF24048 | 1800x400m | Rectangular | Vertical | Internal |
| PF24010-1 | 1000x500mm | Rectangular | Both | External |
| PF24010-2 | 800mm | Circular | Both | External |
| PF24072 | 800mm | Circular | Vertical | Internal |
| PF24066-1 | 800mm | Circular | Horizontal | External |
| PF24066-2 | 1000x500mm | Rectangular | Horizontal | External |

All tests were conducted as per AS1530.4-2014.

4. Assessment Summary

4.1 Duct Specification and Installation

The duct shall be constructed in accordance with AS4254.2-2012 Pressure class 500 or higher.

FIRESTOP Duct Wrap-38 should be applied to all sides of a rectangular duct except for the situations described in clause 4.9 of this report and to the full circumference of a circular duct.

The duct support system shall use minimum M10 threaded rods and minimum 40 x 40 x 2.4mm trapeze angles, spaced no more than 1800mm apart provided that each section of the duct has separate support. The loads associated with the support system shall not exceed the following:

| Type of Load | Maximum Stresses for up to 120 minutes (N/mm ²) |
|---|---|
| Tensile stress in all vertical components | 6 |
| Bending stress in trapeze angle | 6.5 |
| Shearing stress in screws | 10 |

Support systems for ducts larger than 1000x500mm or 800mm diameter shall use a higher specification in accordance with AS4254.2-2012.

For asymmetrical installations the protection shall be exposed to fire as tested.

For two-way systems – FIRESTOP Duct Wrap-38 shall be installed on both sides of the separating element.

For one-way systems (internal fire) - FIRESTOP Duct Wrap-38 shall be installed on non-fire side of the separating element.

For one-way systems (external fire) - FIRESTOP Duct Wrap-38 shall be installed on fire side of the separating element.

Where the duct penetrates the vertical or horizontal separation, the duct shall not provide any structural support to the separation.

4.2 Duct Penetration Details

4.2.1 Detail A - Rectangular Duct exposed to Internal or External Fire

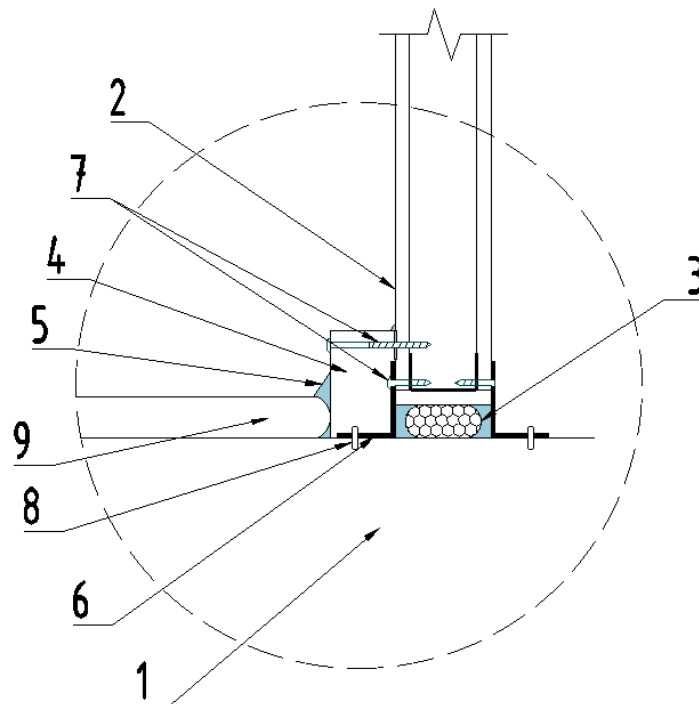


Fig. 1 – Penetration detail A

Table 2: Penetration detail A Characteristics

| Item Number | Description |
|-------------|---|
| 1 | Air Duct Horizontal ducts - up to -/120/120 Vertical ducts - up to -/120/120 - Rectangular ducts exposed to internal or external fire |
| 2 | Separating Element Up to 60/60/60*: <ul style="list-style-type: none"> - minimum 64mm steel or 90x45mm timber stud with a minimum of one layer of min 13mm thick FR plasterboard on each side - minimum 90mm thick concrete/masonry wall or concrete floor. - Minimum 90mm timber joist floor with minimum one layer of 16mm FR plasterboard underneath and 19mm plywood board on the top. |

| | |
|----------|---|
| | <p>Up to 120/120/120*:</p> <ul style="list-style-type: none"> - minimum 92mm steel or 90x45mm timber stud with a minimum of two layers of min 13mm thick FR plasterboard on each side - minimum 120mm thick concrete/masonry wall or concrete floor <p>* - refer to the manufacturer-stated fire resistance performance of separating element</p> |
| 3 | <p>Aperture</p> <ul style="list-style-type: none"> - Rectangular aperture in Plasterboard wall, concrete/masonry wall or concrete floor and timber joist floor - Annular gap 10 – 30mm <p>The annular gap shall be sealed with</p> <ul style="list-style-type: none"> - For Plasterboard lined walls or timber joist floors – Aperture to be lined with 13mm FR Plasterboard. Protecta FR Acrylic Sealant or FIRESTOP Ultra Acrylic Sealant installed to 20mm depth within aperture from both sides. Unfoiled Ductwrap-38 shall be used as backing for sealant. - For concrete/masonry wall or concrete floor – Protecta FR Acrylic Sealant or FIRESTOP Ultra Acrylic Sealant installed to 20mm depth within aperture from both sides. Unfoiled Ductwrap-38 shall be used as backing for sealant |
| 4 | <p>FR Board Collar</p> <ul style="list-style-type: none"> - All unpainted edges of the FR Board shall be painted with Protecta FR Coating or covered with Protecta FR Acrylic Sealant or FIRESTOP Ultra Acrylic Sealant - FR Board to be fixed to separating element using screws at 200mm centres <p>For a One-Way system (internal fire):</p> <ul style="list-style-type: none"> - Minimum 100mm wide, 60mm thick collar made of Protecta FR Board 2S collar to be installed on non-fire side only, overlapping the separating element on all sides by minimum 80mm. <p>For a One-Way system (external fire):</p> <ul style="list-style-type: none"> - Vertical separating element - Minimum 100mm wide, 60mm thick collar made of Protecta FR Board 2S collar to be installed on fire side only, overlapping the separating element on all sides by minimum 100mm. - Horizontal separating element - Minimum 100mm wide, 60mm thick collar made of Protecta FR Board 2S collar to be installed on |

| | |
|----------|---|
| | <p>both sides, overlapping the separating element on all sides by minimum 100mm.</p> <p>For a two-way system (internal and external fire):</p> <ul style="list-style-type: none"> - Identical to One-Way system installed on both sides of the separating element. |
| 5 | <p>Acrylic Sealant</p> <p>Protecta FR acrylic sealant or FIRESTOP Ultra Acrylic sealant shall be installed in the following locations:</p> <ul style="list-style-type: none"> - Between FR Board collar and Separating element - Between FR Board and Duct - Between FR Board and Wrap - Between Angle – Duct junction - Applied to all joints in FR Board Collar <p>Protecta FR acrylic sealant or FIRESTOP Ultra Acrylic sealant applied to unpainted surfaces of FR Board</p> |
| 6 | <p>Steel Angle Collar</p> <ul style="list-style-type: none"> - Minimum 75mmx75mmx1.2mm steel angles shall be installed on both sides of the separating element |
| 7 | <p>Fixings</p> <ul style="list-style-type: none"> - The angle shall be fixed to the separating element using drywall screws (for plasterboard walls) or concrete screws (for concrete/masonry walls) at maximum 50mm from the end of each frame section at maximum 200mm centres. Minimum 6g x 32mm fixings shall be used - The FR Board collar shall be fixed to the separating element using drywall screws (for plasterboard walls) or concrete screws (for concrete/masonry walls) at maximum 50mm from the end of each frame section at maximum 200mm centres. Minimum 8g x 75mm fixings shall be used |
| 8 | <p>Steel rivet</p> <ul style="list-style-type: none"> - The angle shall be fixed to the duct using minimum 4.8mm OD Stainless Steel rivets at 100mm centres |
| 9 | <p>Firestop Ductwrap</p> <ul style="list-style-type: none"> - 38mm thick duct wrap shall be installed as per duct protection requirements (Sections 4.4-4.6) |

4.2.2 Detail B - Rectangular Duct exposed to Internal Fire

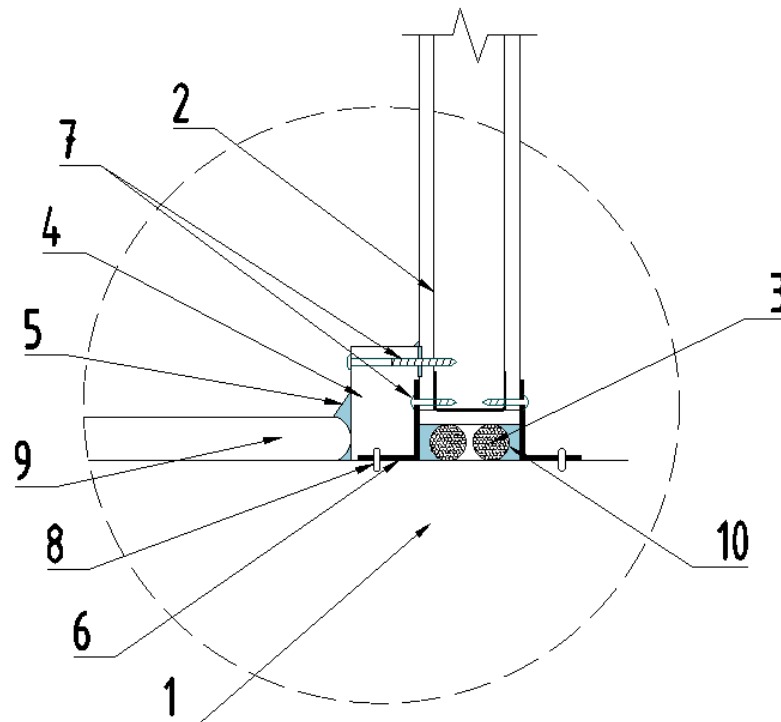


Fig. 2 – Penetration detail B

Table 3: Penetration detail B Characteristics

| Item Number | Description |
|-------------|--|
| 1 | Air Duct Horizontal ducts up to -/90/60 <ul style="list-style-type: none"> - Rectangular duct exposed to Internal fire |
| 2 | Separating Element Up to 60/60/30* <ul style="list-style-type: none"> - minimum 64mm steel or 90x45mm timber stud with a minimum of one layer of min 13mm thick FR plasterboard on each side - minimum 90mm thick concrete/masonry wall Up to 90/90/60* <ul style="list-style-type: none"> - minimum 90mm steel or timber stud with a minimum of two layers of min 13mm thick FR plasterboard on each side |

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|----------|--|
| | <ul style="list-style-type: none"> - minimum 140mm thick concrete/masonry wall <p>* - refer to the manufacturer-stated fire resistance performance of separating element</p> |
| 3 | <p>Aperture</p> <ul style="list-style-type: none"> - Rectangular aperture plasterboard wall or concrete/masonry wall or concrete floor - Annular gap 10 – 30mm <p>The annular gap shall be sealed with</p> <ul style="list-style-type: none"> - For Plasterboard lined walls or concrete/masonry walls – Aperture to be lined with 13mm FR Plasterboard. - PEF Rod installed into aperture from both sides - Protecta FR Graphite Sealant installed to 20mm depth within aperture from both sides |
| 4 | <p>FR Board Collar</p> <ul style="list-style-type: none"> - All unpainted edges of the FR Board shall be painted with Protecta FR Coating or covered with Protecta FR Acrylic Sealant or FIRESTOP Ultra Acrylic Sealant - FR Board to be fixed to separating element using screws at 200mm centres <p>For a One-Way system (internal fire):</p> <ul style="list-style-type: none"> - Minimum 100mm wide, 60mm thick collar made of Protecta FR Board 2S collar to be installed on non-fire side only, overlapping the aperture on all sides by minimum 70mm. <p>For a two-way system (internal and external fire):</p> <ul style="list-style-type: none"> - Identical to One-Way system installed on both sides of the separating element. |
| 5 | <p>Acrylic Sealant</p> <p>Protecta FR acrylic sealant or FIRESTOP Ultra Acrylic sealant shall be installed in the following locations:</p> <ul style="list-style-type: none"> - Between FR Board collar and Separating element - Between FR Board and Duct - Between FR Board and Wrap - Between Angle – Duct junction - Applied to all joints in FR Board Collar <p>Protecta FR acrylic sealant or FIRESTOP Ultra Acrylic sealant applied to unpainted surfaces of FR Board</p> |

| | |
|-----------|---|
| 6 | <p>Steel Angle Collar</p> <ul style="list-style-type: none"> - Minimum 75mmx75mmx1.2mm steel angles shall be installed on both sides of the separating element |
| 7 | <p>Fixings</p> <ul style="list-style-type: none"> - The angle shall be fixed to the separating element using drywall screws (for plasterboard walls) or concrete screws (for concrete/masonry walls) at maximum 50mm from the end of each frame section at maximum 200mm centres. Minimum 6g x 32mm fixings shall be used - The FR Board collar shall be fixed to the separating element using drywall screws (for plasterboard walls) or concrete screws (for concrete/masonry walls) at maximum 50mm from the end of each frame section at maximum 200mm centres. Minimum 8g x 75mm fixings shall be used |
| 8 | <p>Steel rivet</p> <ul style="list-style-type: none"> - The angle shall be fixed to the duct using minimum 4.8mm OD Stainless Steel rivets at 100mm centres |
| 9 | <p>Firestop Ductwrap</p> <ul style="list-style-type: none"> - 38mm thick duct wrap shall be installed as per duct protection requirements |
| 10 | <p>Graphite Sealant</p> <ul style="list-style-type: none"> - Protecta FR Graphite Sealant installed to 20mm depth within aperture from both sides |

4.2.3 Detail C - Circular Duct exposed to Internal Fire or External Fire

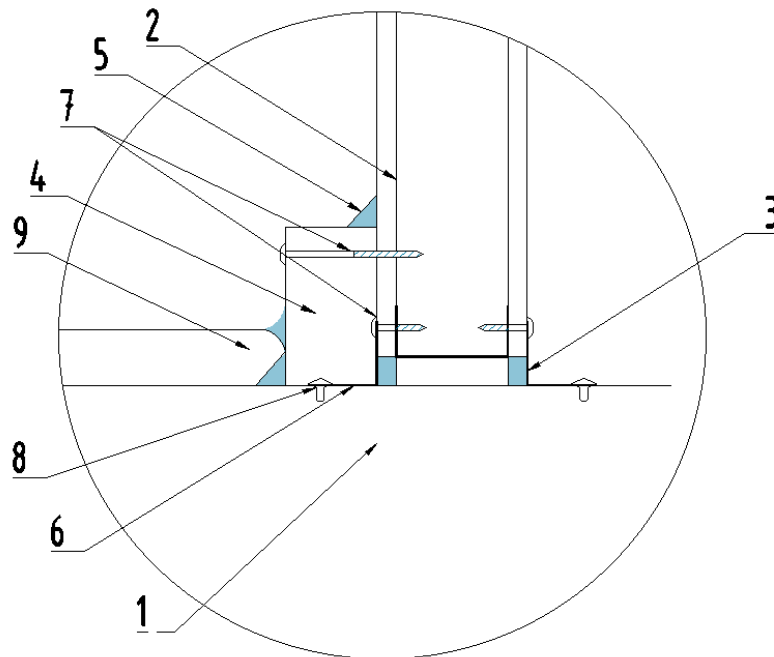


Fig. 3 – Penetration detail C

Table 4: Penetration detail C Characteristics

| Item Number | Description |
|-------------|---|
| 1 | <p>Air Duct</p> <p>Horizontal ducts up to -/120/120</p> <p>Vertical ducts up to -/120/120</p> <ul style="list-style-type: none"> - Circular duct exposed to Internal or External fire |
| 2 | <p>Separating Element</p> <p>Up to 60/60/60*:</p> <ul style="list-style-type: none"> - minimum 76mm steel or 90x45mm timber stud with a minimum of one layer of min 13mm thick FR plasterboard on each side of the wall. The framed wall shall have stud spacing wide enough to accommodate the duct, with additional nogs above and below the duct. - minimum 100mm thick concrete/masonry wall or minimum 100mm thick concrete floor. |

| | |
|---|---|
| | <ul style="list-style-type: none"> - Minimum 90mm timber joist floor with minimum one layer of 16mm FR plasterboard underneath and 19mm plywood board on the top (The FR board collar shall be fixed to the joists on all sides) <p>Up to 120/120/120*:</p> <ul style="list-style-type: none"> - minimum 92mm steel or 90x45mm timber stud with two layers of fire-rated plasterboard on both sides of the wall. The framed wall shall have stud spacing wide enough to accommodate the duct, with additional nogs above and below the duct. - minimum 120mm thick concrete/masonry wall - minimum 120mm thick concrete floor <p>* - refer to the manufacturer-stated fire resistance performance of separating element</p> |
| 3 | <p>Aperture</p> <ul style="list-style-type: none"> - Circular aperture plasterboard wall or concrete/masonry wall or concrete floor - Annular gap 10 – 30mm <p>The annular gap shall be sealed with</p> <ul style="list-style-type: none"> - For Plasterboard lined walls – Protecta FR Acrylic Sealant or FIRESTOP Ultra Acrylic sealant to the depth of plasterboard lining - For concrete/masonry walls or floors - 20mm deep Protecta FR Acrylic Sealant or FIRESTOP Ultra Acrylic sealant on both sides of the separating element. Unfoiled Ductwrap-38 shall be used as backing for the remaining depth of the separating element. |
| 4 | <p>FR Board Collar</p> <ul style="list-style-type: none"> - All unpainted edges of the FR Board shall be painted with Protecta FR Coating or covered with Protecta FR Acrylic Sealant or FIRESTOP Ultra Acrylic Sealant - FR Board to be fixed to separating element using screws at 200mm centres - For concrete floors – FR board collars are required on the top of the separating element. - For framed walls – the FR board shall be fixed to framing on all sides - <p>For a One-Way system (internal fire):</p> <ul style="list-style-type: none"> - Minimum 100mm wide, 60mm thick collar made of Protecta FR Board 2S collar to be installed on non-fire side only, overlapping the separating element on all sides by minimum 80mm. |

| | |
|-----------------|---|
| | <p>For a One-Way system (external fire):</p> <ul style="list-style-type: none"> - Vertical separating element - Minimum 100mm wide, 60mm thick collar made of Protecta FR Board 2S collar to be installed on fire side only, overlapping the separating element on all sides by minimum 100mm. - Horizontal separating element - Minimum 100mm wide, 60mm thick collar made of Protecta FR Board 2S collar to be installed on both sides, overlapping the separating element on all sides by minimum 100mm. <p>For a two-way system (internal and external fire):</p> <p>Identical to One-Way system installed on both sides of the separating element.</p> |
| <p>5</p> | <p>Acrylic Sealant</p> <p>Protecta FR acrylic sealant or FIRESTOP Ultra Acrylic sealant shall be installed in the following locations:</p> <ul style="list-style-type: none"> - Between FR Board collar and Separating element - Between FR Board and Duct - Between FR Board and Wrap - Between Angle – Duct junction - Applied to all joints in FR Board Collar <p>Protecta FR acrylic sealant or FIRESTOP Ultra Acrylic sealant applied to unpainted surfaces of FR Board</p> |
| <p>6</p> | <p>Steel Angle Collar</p> <ul style="list-style-type: none"> - Minimum 75mmx75mmx0.8mm steel angles (slotted or prefabricated) shall be installed on both sides of the separating element - For framed walls, Steel angle collar shall be fixed to the studs and nogs where possible minimum 3 fixings point per side. Where the angle does not overlap with framing, the angle shall be fixed directly to the plasterboard |
| <p>7</p> | <p>Fixings</p> <ul style="list-style-type: none"> - The angle shall be fixed to the separating element using drywall screws (for plasterboard walls) or concrete screws (for concrete/masonry walls) at maximum 50mm from the end of each frame section at maximum 200mm centres. Minimum 6g x 32mm fixings shall be used - The FR Board collar shall be fixed to the separating element using drywall screws (for plasterboard walls) or concrete screws (for concrete/masonry walls) at maximum 50mm from the end of each |

| | |
|----------|--|
| | frame section at maximum 200mm centres. Minimum 8g x 75mm fixings shall be used |
| 8 | <p>Steel rivet</p> <ul style="list-style-type: none"> - The angle shall be fixed to the duct using minimum 4.8mm OD Stainless Steel rivets at 100mm centres |
| 9 | <p>Firestop Ductwrap</p> <ul style="list-style-type: none"> - 38mm thick duct wrap shall be installed as per duct protection requirements |

4.2.4 Detail D - Circular or Rectangular Duct exposed to Internal Fire

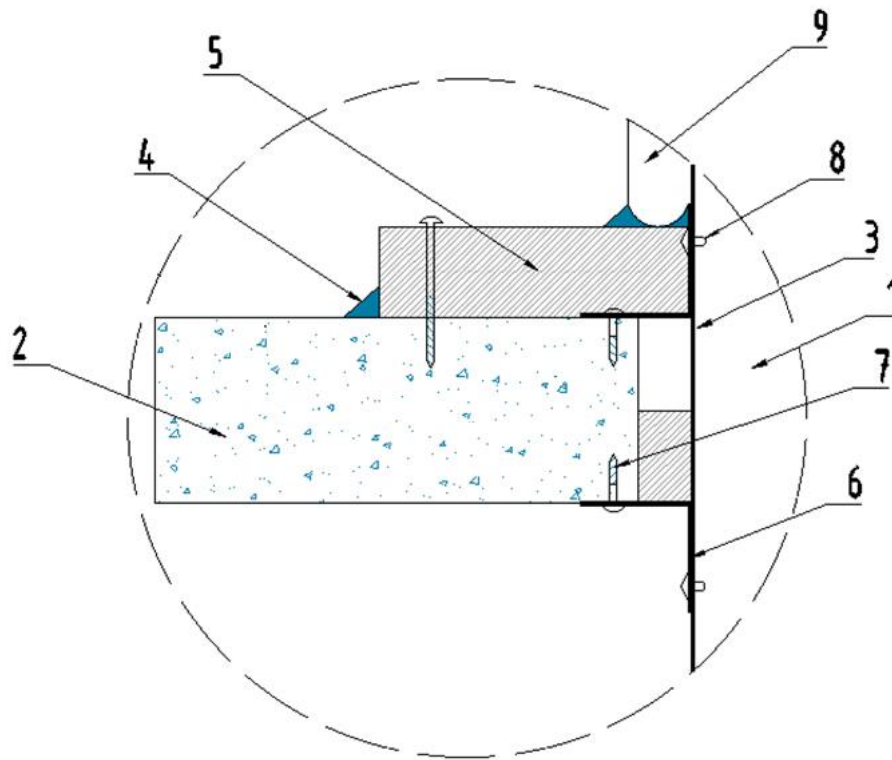


Fig. 4 – Penetration detail D

Table 5: Penetration detail D Characteristics

| Item Number | Description |
|-------------|---|
| 1 | Air Duct Horizontal ducts up to -/120/120 Vertical ducts up to -/120/120 - Circular or Rectangular duct exposed to Internal fire |
| 2 | Separating Element Up to 120/120/120: - minimum 120mm thick concrete floor. - minimum 120mm thick concrete/masonry wall. |
| 3 | Aperture - Rectangular aperture through concrete/masonry wall or concrete floor. - Annular gap 20 – 170mm |

| | |
|----------|--|
| | <ul style="list-style-type: none"> - Protecta FR Board shall be cut to the shape of the annular gap and friction fitted between the duct and separating element, flush with the separating element. |
| 4 | <p>Acrylic Sealant</p> <p>FIRESTOP Ultra Acrylic sealant shall be installed in the following locations:</p> <ul style="list-style-type: none"> - Between FR Board collar and Separating element - Between FR Board and Duct - Between FR Board and Wrap - Between Angle – Duct junction - Applied to all joints in FR Board Collar <p>All unpainted edges of the FR Board shall be painted with Protecta FR Coating or covered with Protecta FR Acrylic Sealant or FIRESTOP Ultra Acrylic Sealant</p> |
| 5 | <p>FR Board Collar</p> <ul style="list-style-type: none"> - One layer of the Protecta FR Board 2S shall be installed within the aperture between the duct and separating element, all gaps and joints shall be sealed with sealant - 60mm thick collar made of Protecta FR Board 2S collar to be installed on non-fire side only, extending from the duct by minimum 100mm on all sides. FR Board to be fixed to separating element using screws at 200mm centres - Minimum 80mm overlap with separating element |
| 6 | <p>Steel Angle Collar</p> <ul style="list-style-type: none"> - For Circular ducts minimum 75mmx75mmx0.8mm steel angles (slotted or prefabricated) shall be installed on both sides of the separating element. - For Rectangular ducts minimum 75x75x1.2mm steel angles shall be used for the annular gap up to 30mm. - For annular gaps exceeding 30mm the steel angle shall be increased having minimum 45mm overlap with separating element and the metal thickness shall be increased to min 2mm. |
| 7 | <p>Fixings</p> <ul style="list-style-type: none"> - The angle shall be fixed to the separating element using concrete screws (for concrete/masonry walls) at maximum 50mm from the end of each frame section at maximum 200mm centres. Minimum 6g x 32mm fixings shall be used. - For circular duct – the quantity of fixings may be reduced provided minimum of three fixings per side of the aperture |

| | |
|----------|--|
| | <ul style="list-style-type: none"> - The FR Board collar shall be fixed to the separating element using concrete screws (for concrete/masonry walls) at maximum 50mm from the end of each frame section at maximum 200mm centres. Minimum 8g x 75mm fixings shall be used |
| 8 | <p>Steel rivet</p> <ul style="list-style-type: none"> - The angle shall be fixed to the duct using minimum 4.8mm OD Stainless Steel rivets at 100mm centres |
| 9 | <p>Firestop Ductwrap</p> <ul style="list-style-type: none"> - 38mm thick duct wrap shall be installed as per duct protection requirements |

4.2.5 Detail E – Circular or Rectangular Duct exposed to External or Internal Fire

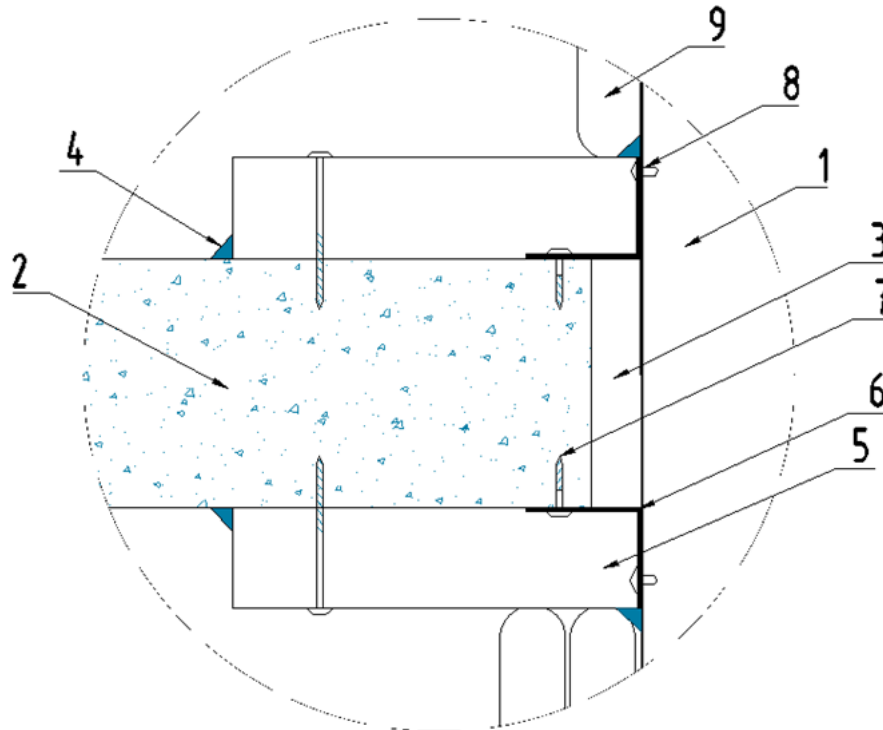


Fig. 5 – Penetration detail E

Table 6: Penetration detail E Characteristics

| Item Number | Description |
|-------------|---|
| 1 | Air Duct Horizontal ducts up to -/120/120 Vertical ducts up to -/120/120 - Circular duct exposed to external or internal fire - Rectangular duct exposed to external or internal fire |
| 2 | Separating Element Up to 60/60/60: - minimum 100mm thick concrete/masonry wall or minimum 100mm thick concrete floor. |

| | |
|----------|---|
| | <p>Up to 120/120/120:</p> <ul style="list-style-type: none"> - minimum 150mm thick concrete floor. - minimum 150mm thick concrete/masonry wall. |
| 3 | <p>Aperture</p> <ul style="list-style-type: none"> - Rectangular aperture through concrete/masonry wall or concrete floor. - Annular gap up to 200mm |
| 4 | <p>Acrylic Sealant</p> <p>Protecta FR acrylic sealant or FIRESTOP Ultra Acrylic sealant shall be installed in the following locations:</p> <ul style="list-style-type: none"> - Between FR Board collar and Separating element - Between FR Board and Duct - Between FR Board and Wrap - Between Angle – Duct junction - Applied to all joints in FR Board Collar <p>All unpainted edges of the FR Board shall be painted with Protecta FR Coating or covered with Protecta FR Acrylic Sealant or FIRESTOP Ultra Acrylic Sealant</p> |
| 5 | <p>FR Board Collar</p> <ul style="list-style-type: none"> - FR Board to be fixed to separating element using screws at 200mm centres - Minimum 80mm overlap with separating element - 60mm thick collar made of Protecta FR Board 2S collar to be installed on both sides of the separating element, extending from the duct by minimum 100mm on all sides. |
| 6 | <p>Steel Angle Collar</p> <ul style="list-style-type: none"> - For Circular ducts minimum 75mmx75mmx0.8mm steel angles (slotted or prefabricated) shall be installed on both sides of the separating element. - For Rectangular ducts minimum 75x75x1.2mm steel angles shall be used for the annular gap up to 30mm. For annular gaps exceeding 30mm the steel angle shall be increased having minimum 45mm overlap with separating element and the metal thickness shall be increased to min 2mm. |
| 7 | <p>Fixings</p> <ul style="list-style-type: none"> - The angle shall be fixed to the separating element using concrete screws (for concrete/masonry walls) at maximum 50mm from the |

| | |
|---|---|
| | <p>end of each frame section at maximum 200mm centres. Minimum 6g x 32mm fixings shall be used.</p> <ul style="list-style-type: none"> - For circular duct – the quantity of fixings may be reduced provided minimum of three fixings per side of the aperture - The FR Board collar shall be fixed to the separating element using concrete screws (for concrete/masonry walls) at maximum 50mm from the end of each frame section at maximum 200mm centres. Minimum 8g x 75mm fixings shall be used |
| 8 | <p>Steel rivet</p> <ul style="list-style-type: none"> - The angle shall be fixed to the duct using minimum 4.8mm OD Stainless Steel rivets at 100mm centres |
| 9 | <p>Firestop Ductwrap</p> <ul style="list-style-type: none"> - 38mm thick duct wrap shall be installed as per duct protection requirements |

4.3 Duct Dimensions

Rectangular duct sizes, limited by a maximum cross-sectional area of up to 1800000mm² have been positively assessed for both internal and external exposure to fire. Ducts with dimensions within the plotted area may be used, provided the duct has been constructed in accordance with AS4254.2 Pressure class 500 or higher.

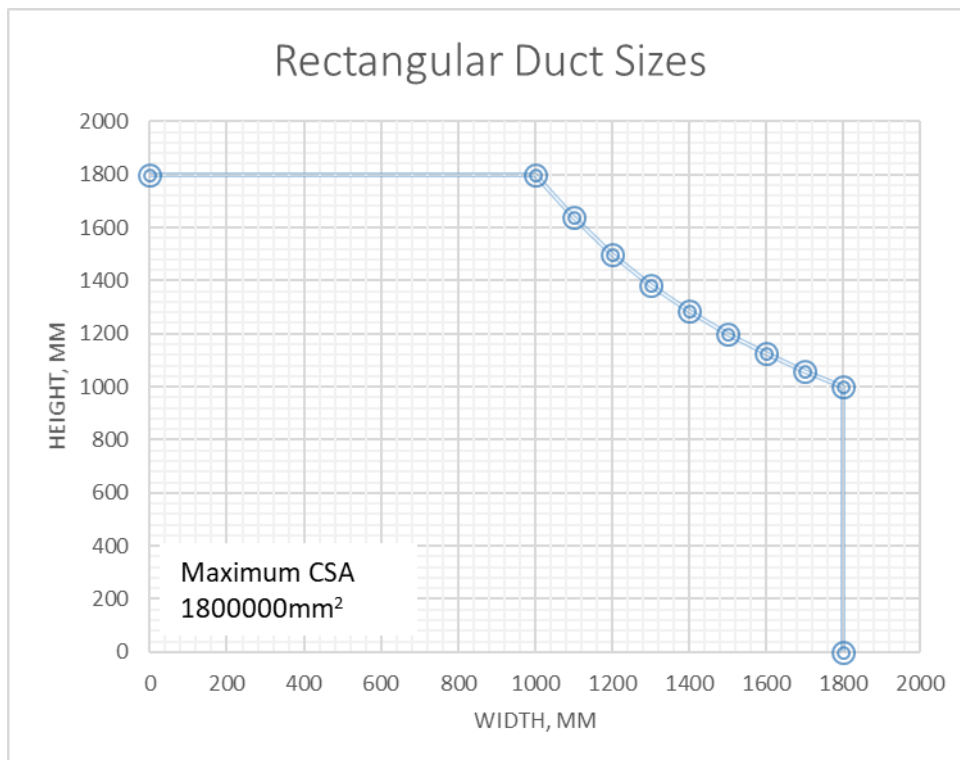


Fig. 6 – Positively assessed rectangular duct sizes

Circular duct sizes, limited by a maximum diameter of up to 1000mm have been positively assessed for both internal and external exposure to fire, provided the duct has been constructed in accordance with AS4254.2 Pressure class 500 or higher.

4.4 Internal Fire Exposure Duct Protection

4.4.1 30 Minutes Protection – Rectangular Duct

Table 7: Rectangular Duct Characteristics for 30-minute protection

| Characteristic | Description | |
|-------------------------------|--|--|
| | 30/30/- | 30/30/30 |
| Penetration | A, D or B (B for horizontal only), E | A, D or B (B for horizontal only), E |
| Wrap cut-off tape | Class 1, 2, or 3 | Class 1 or 2 |
| Joints tape | Class 1, 2, or 3 | Class 1, 2, or 3 |
| Maximum duct size | 1.8m ² CSA | 1.8m ² CSA |
| Protection from internal fire | Horizontal duct: 1 layer Vertical duct: 1 layer | Horizontal duct: 1 layer Vertical duct ≤ 0.64m ² perimeter: 1 layer + 600mm 2 nd layer Vertical duct > 0.64m ² perimeter: 1 layer + 900mm 2 nd layer |

4.4.2 30 Minutes Protection – Circular Duct

Table 8: Circular Duct Characteristics for 30-minute protection

| Characteristic | Description | |
|------------------------|------------------|------------------|
| | 30/30/- | 30/30/30 |
| Penetration | C, D, E | C, D, E |
| Wrap cut-off edge tape | Class 1, 2, or 3 | Class 1 or 2 |
| Joints tape | Class 1, 2, or 3 | Class 1, 2, or 3 |

| | | |
|-------------------------------|--|---|
| Maximum duct size | 1000mm OD | 1000mm OD |
| Protection from internal fire | Horizontal duct: 1 layer Vertical duct: 1 layer | Horizontal duct: 1 layer Vertical duct: 1 layer + 1600mm 2 nd layer |

4.4.3 60 Minutes Protection – Rectangular Duct

Table 9: Rectangular Duct Characteristics for 60-minute protection

| Characteristic | Description | | |
|-------------------------------|--|--|--|
| | 60/60/- | 60/60/30 | 60/60/60 |
| Penetration | A, D or B (B for horizontal only) , E | A, D or B (B for horizontal only) , E | A, D or B (B for horizontal only) , E |
| Wrap cut-off tape | Class 1, 2, or 3 | Class 1 or 2 | Class 1 or 2 |
| Joints tape | Class 1, 2, or 3 | Class 1, 2, or 3 | Class 1 or 2 |
| Maximum duct size | 1.8m ² CSA | 1.8m ² CSA | 1.8m ² CSA |
| Protection from internal fire | Horizontal duct: 1 layer Vertical duct: 1 layer | Horizontal duct: 1 layer Vertical duct ≤ 0.64m ² perimeter: 1 layer + 600mm 2 nd layer Vertical duct > 0.64m ² perimeter: 1 layer + 900mm 2 nd layer | Horizontal duct: 1 layer + 1400mm 2 nd layer Vertical duct ≤ 0.64m ² perimeter: 1 layer + 1900mm 2 nd layer Vertical duct > 0.64m ² perimeter: 1 layer + 1780mm 2 nd layer, 860mm 3 rd layer |

4.4.4 60 Minutes Protection – Circular Duct

Table 10: Circular Duct Characteristics for 60-minute protection

| Characteristic | Description | | |
|-------------------------------|--|---|--|
| | 60/60/- | 60/60/30 | 60/60/60 |
| Penetration | C, D, E | C, D, E | C, D, E |
| Wrap cut-off tape | Class 1, 2, or 3 | Class 1 or 2 | Class 1 or 2 |
| Joints tape | Class 1, 2, or 3 | Class 1, 2, or 3 | Class 1 or 2 |
| Maximum duct size | 1000mm OD | 1000mm OD | 1000mm OD |
| Protection from internal fire | Horizontal duct: 1 layer Vertical duct: 1 layer | Horizontal duct: 1 layer Vertical duct: 1 layer + 1600mm 2 nd layer | Horizontal duct: 1 layer + 1900mm 2 nd layer Vertical duct: 1 layer + 2100mm 2 nd layer |

4.4.5 120 Minutes Protection – Rectangular Duct

Table 11: Rectangular Duct Characteristics for up to 120-minute protection

| Characteristic | Description | | | | |
|-------------------------------|--------------------------|--|---|----------------------------|---|
| | 120/120/- | 120/120/30 | 120/120/60 | 120/120/90 | 120/120/120 |
| Penetration | A, D, E | A, D, E | A, D, E | A, D, E | A, D, E |
| Wrap cut-off tape | Class 1, 2, or 3 | Class 1 or 2 | Class 1 or 2 | Class 1 | Class 1 |
| Joints tape | Class 1, 2, or 3 | Class 1, 2, or 3 | Class 1 or 2 | Class 1 | Class 1 |
| Maximum duct size | 1.8m ² CSA | 1.8m ² CSA | 1.8m ² CSA | 1.8m ² CSA | 1.8m ² CSA |
| Protection from internal fire | Horizontal duct: 1 layer | Horizontal duct: 1 layer Vertical duct ≤ 0.64m ² | Horizontal duct: 1 layer + 1400mm 2 nd layer | Horizontal duct: 1 layer + | Horizontal duct: 1 layer + 1900mm 2 nd layer |



| | | | | | |
|--|------------------------|---|---|---|---|
| | Vertical duct: 1 layer | perimeter: 1 layer + 600mm 2 nd layer Vertical duct > 0.64m ² perimeter: 1 layer + 900mm 2 nd layer | Vertical duct ≤ 0.64m ² perimeter: 1 layer + 1900mm 2 nd layer Vertical duct > 0.64m ² perimeter: 1 layer + 1780mm 2 nd layer, 860mm 3 rd layer | 1900mm 2 nd layer Vertical duct: 1 layer + 2040mm 2 nd layer, 1660mm 3 rd layer | Vertical duct: 1 layer + 2040mm 2 nd layer, 1660mm 3 rd layer |
|--|------------------------|---|---|---|---|

4.4.6 120 Minutes Protection – Circular Duct

Table 12: Circular Duct Characteristics for up to 120-minute protection

| Characteristic | Description | | | | |
|-------------------------------|--|---|--|--|--|
| | 120/120/- | 120/120/30 | 120/120/60 | 120/120/90 | 120/120/120 |
| Penetration | C, D, E | C, D, E | C, D, E | C, D, E | C, D, E |
| Wrap cut-off tape | Class 1, 2, or 3 | Class 1 or 2 | Class 1 or 2 | Class 1 | Class 1 |
| Joints tape | Class 1, 2, or 3 | Class 1, 2, or 3 | Class 1 or 2 | Class 1 | Class 1 |
| Maximum duct size | 1000mm OD | 1000mm OD | 1000mm OD | 1000mm OD | 1000mm OD |
| Protection from internal fire | Horizontal duct: 1 layer Vertical duct: 1 layer | Horizontal duct: 1 layer Vertical duct: 1 layer + 1600mm 2 nd layer | Horizontal duct: 1 layer + 1900mm 2 nd layer Vertical duct: 1 layer + 2100mm 2 nd layer | Horizontal duct: 1 layer + 4300mm 2 nd layer Vertical duct: 1 layer + 2100mm 2 nd layer | Horizontal duct: 1 layer + 4550mm 2 nd layer Vertical duct: 1 layer + 2100mm 2 nd layer |



4.5 External Fire Exposure Duct Protection

4.5.1 60 Minutes Protection

Table 13: Rectangular and Circular Duct Characteristics for up to 60-minute protection

| Characteristic | Description | |
|-------------------------------|--------------------------------------|---------------------------|
| | Rectangular Duct 60/60/30 | Circular Duct 60/60/30 |
| Penetration | A, E | C, E |
| Wrap cut-off tape | Class 1 | Class 1 |
| Joints tape | Class 1 | Class 1 |
| Maximum duct size | 1800x1000mm or 1.8m ² CSA | 1000mm |
| Protection from external fire | 1 layer | 1 layer |

4.5.2 120 Minutes Protection

Table 14: Rectangular and Circular Duct Characteristics for up to 120-minute protection

| Characteristic | Description | |
|-------------------------------|---------------------------------------|-----------------------------|
| | Rectangular Duct Up to 120/120/120 | Circular Duct 120/120/90 |
| Penetration | A, E | C, E |
| Wrap cut-off tape | Class 1 | Class 1 |
| Joints tape | Class 1 | Class 1 |
| Maximum duct size | 1800x1000mm or 1.8m ² CSA | 1000mm |
| Protection from external fire | 2 layers | 2 layers |

4.6 Wrap Fixings, Overlap and Joint Treatment

4.6.1 Wrap Overlap

The following overlapping methods are permitted for duct wrap protection application. A minimum overlap of 100mm must be maintained.

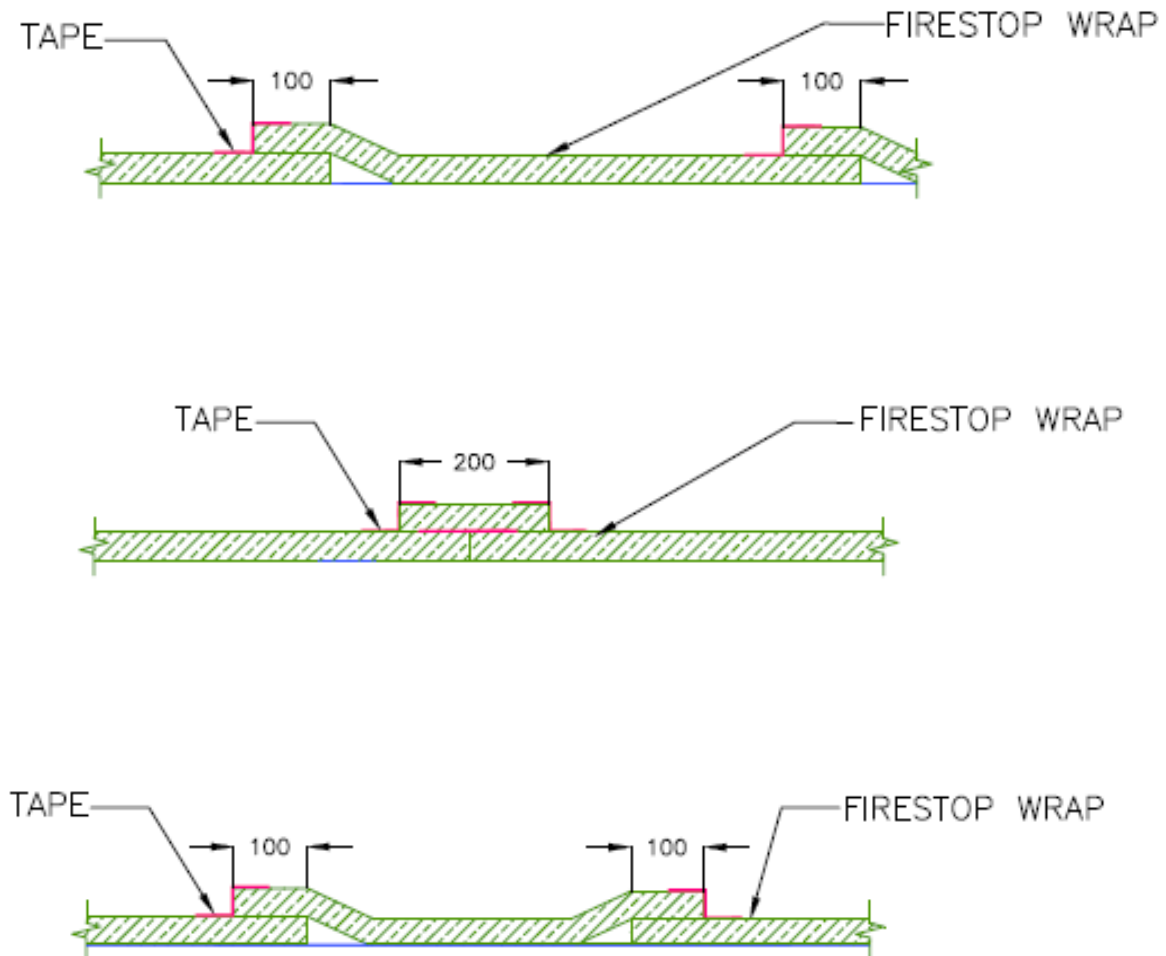


Fig. 7 – Permissible wrap overlap methods (fixings are excluded and one layer overlap is shown for clarity, if the protection requires multiple layers - the same shall be applied each layer)

4.6.2 Wrap Fixing method

The following wrap fixing methods may be used to secure the duct wrap protection to the duct for internal fire systems.

Horizontal orientation:

Up to 800 x 800mm – stainless steel straps or welded pins

Up to 300mm diameter - stainless steel straps or welded pins

Vertical orientation:

Up to 300 x 300mm - stainless steel straps or welded pins

Up to 300mm diameter - stainless steel straps or welded pins

For ducts exceeding the above dimensions and for all external fire systems, welded pins must be used.

Where stainless steel straps are to be used, the straps shall be minimum 12mm wide and 0.15mm thick. The steel straps shall be installed at 300+/-50mm centres, as well as 50+/-15mm from the ends of all layers of wrap.

Where welded pins are to be used, steel or copper-plated steel pins with a diameter of 2.5mm – 3.2mm shall be used. Different lengths of pins shall be used depending on the thickness of the wrap, in accordance with the table below. Pins shall be fixed at maximum 200+/-50mm centres along the width and length of the duct and shall be fixed 50+/-15mm from the ends of all layers of wrap.

Where more than one layer of wrap is required, each layer must be strapped or pinned separately. Where straps are used initially to secure wrap on larger ducts prior to pinning, the straps may be left in place.

Table 15: Required welded pin lengths

| Thickness of Ductwrap used | Pin length (minimum) | Pin length (maximum) |
|----------------------------|----------------------|----------------------|
| 1 x 38mm | 25mm | 40mm |
| 2 x 38mm | 63mm | 82mm |
| 3 x 38mm | 95mm | 120mm |

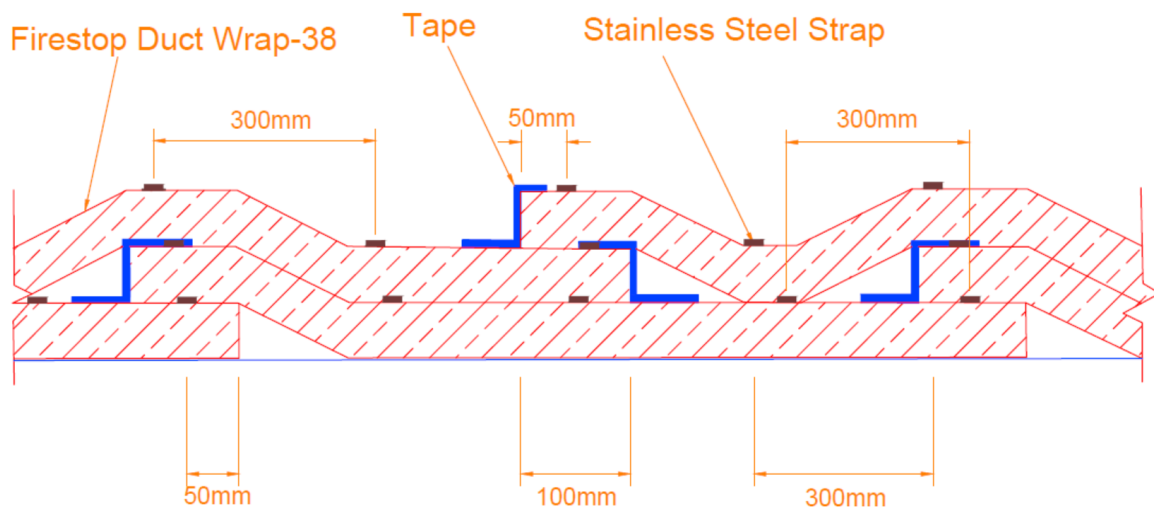


Fig 8a – Fixing method using stainless steel straps

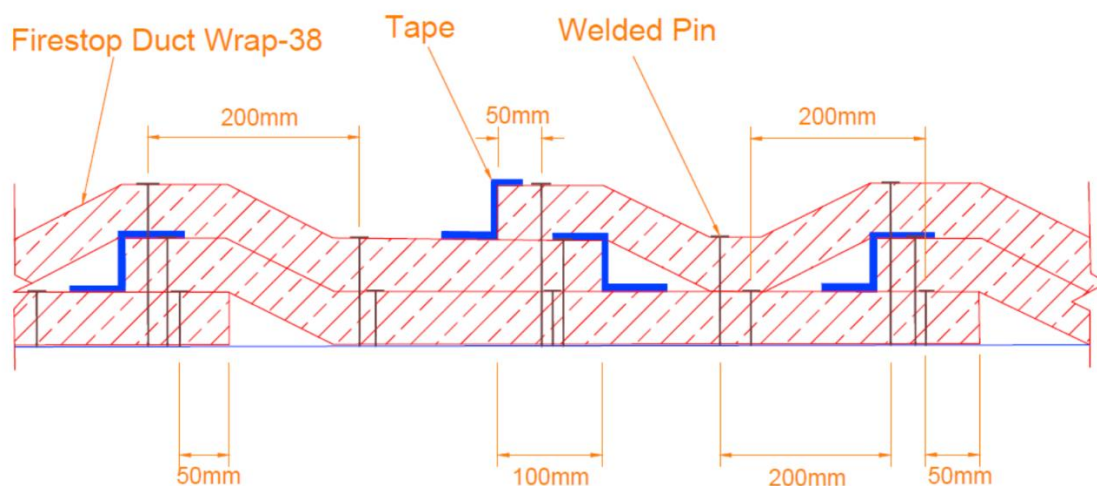


Fig 8b – Fixing method using welded pins

4.6.3 Tape for Joints and Cut-off Ends

Three types of tape may be used, depending on the required insulation rating:

- Class 1: Minimum 50µm thick Aluminium tape with minimum 120°C heat-resistant adhesive. No reinforced aluminium tape is allowed.
- Class 2: Minimum 50µm thick Aluminium tape with minimum 60°C heat-resistant adhesive. No reinforced aluminium tape is allowed.
- Class 3: No tape or any reinforced aluminium tape

4.7 Access Panels

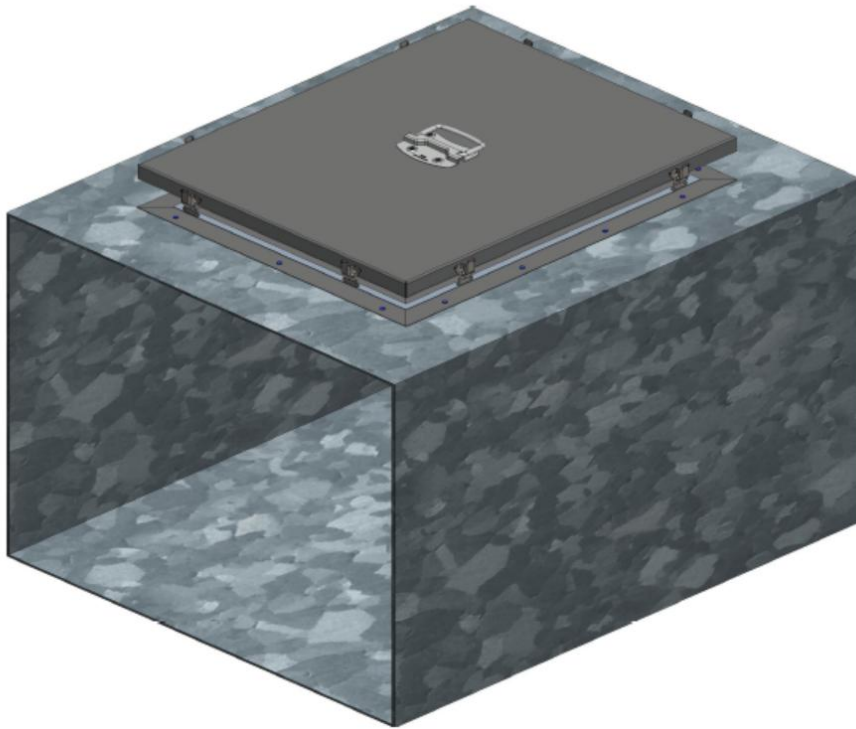


Fig. 9a – FIRESTOP Duct Hatch installed to rectangular duct

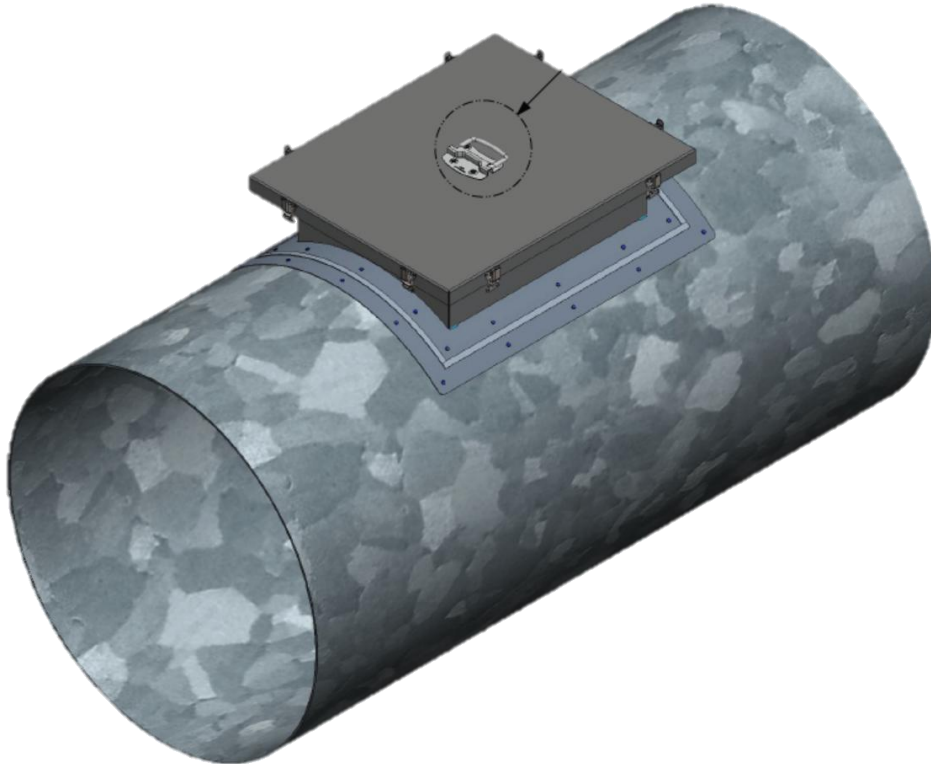


Fig. 9b – FIRESTOP Duct Hatch installed to circular duct

The FIRESTOP Duct Hatch as per the drawings above will achieve the performance described below, provided the following conditions are met:

Table 16: Access panel Ratings and location

| Fire Exposure Condition | Hatch Dimensions (cut out size) | Duct Orientation | Minimum distance from Separating Element | Rating |
|-------------------------|---------------------------------|------------------|--|-----------|
| Internal Fire Exposure | 650mm x 450mm | Horizontal | 1800mm | -/120/120 |
| | 650mm x 450mm | Vertical | 1075mm | -/60/60 |
| | 440mm x 320mm | Horizontal | 1800mm | -/120/120 |
| | 440mm x 320mm | Vertical | 880mm | -/120/120 |
| External Fire Exposure | 315mm x 185mm | Horizontal | 1200mm | -/60/30 |

- The maximum hatch size for circular ducts shall be limited to 440x320 and shall have a FR Board collar installed within the hatch recess. Rectangular ducts may be installed with two layers of recessed Firestop Duct wrap-38 or with 60mm FR Board collar
- For 650mm x 450mm hatches: Hatch shall be protected with minimum one layer of wrap butting into the recess, with an additional layer of wrap installed around the hatch, extending 100mm from all edges
- For 440mm x 320mm hatches – if FR board option is used - A Protecta FR Board collar shall be installed around the perimeter within the hatch, with minimum one layer of wrap butting into the board, with an additional layer of wrap installed around the hatch, extending 100mm from all edges
- Stainless steel rivets shall be used for fixing the hatch to the duct as tested
- The width and length of the hatch may be reduced, but not the thickness of the hatch or part thereof
- Individual components shall not be removed or reduced in size
- The hatch flanges shall overlap and be fixed on all edges around the cut-out
- The hatch cut-out shall be located not less than 100mm from the edge of any rectangular duct
- The fixing centres shall not be increased

4.8 Penetrations and Vertical Duct Supports

4.8.1 Single TPS Cable

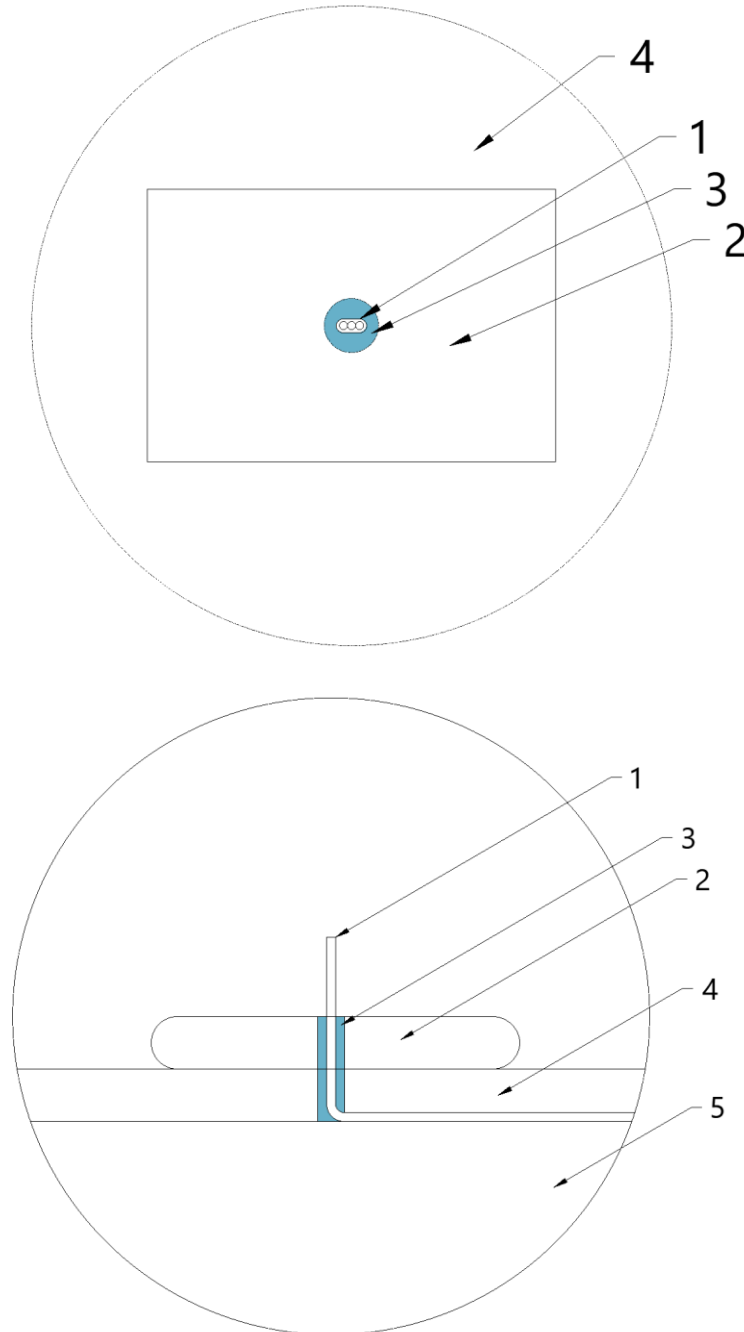


Fig. 10 – TPS Cable penetration Details

A single TPS Cable installed on the outside of a vertical or horizontal duct, penetrating through the duct wrap protection as per the drawing above will achieve an FRL of up to -/120/120, provided the following conditions are met:

Table 17: Single Cable Penetration Characteristics

| Item Number | Description |
|--------------------|--|
| 1 | Service <ul style="list-style-type: none">- One 2.5mm² 2C+E TPS Cable |
| 2 | Penetration Protection <ul style="list-style-type: none">- Minimum 150mm x 200mm DuctWrap-38 patch to be installed on top of the cable penetration |
| 3 | Acrylic sealant <ul style="list-style-type: none">- FIRESTOP Ultra Acrylic sealant installed into Ductwrap Aperture |
| 4 | Firestop Ductwrap <ul style="list-style-type: none">- 38mm thick duct wrap shall be installed as per duct protection requirements |
| 5 | Air Duct |

- The single TPS shall be protected using a minimum 150mm x 200mm ductwrap patch, with FIRESTOP Ultra Acrylic Sealant installed in the penetration
- The penetration shall be located not less than 1300mm from the separating element
- In areas where the cable penetrates through two layers of wrap, an additional 200mm x 150mm patch shall still be installed.

4.8.2 Sprinkler Pipe

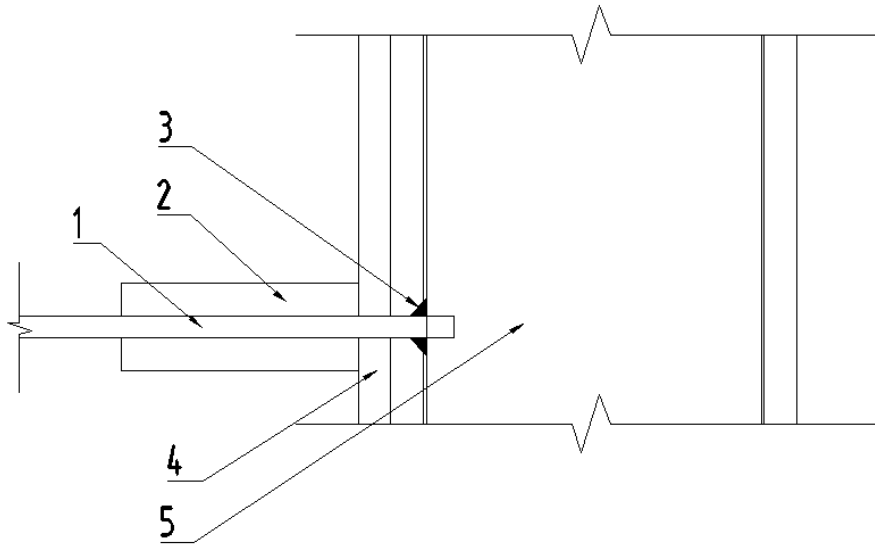


Fig. 11 – Pipe Protection A Details

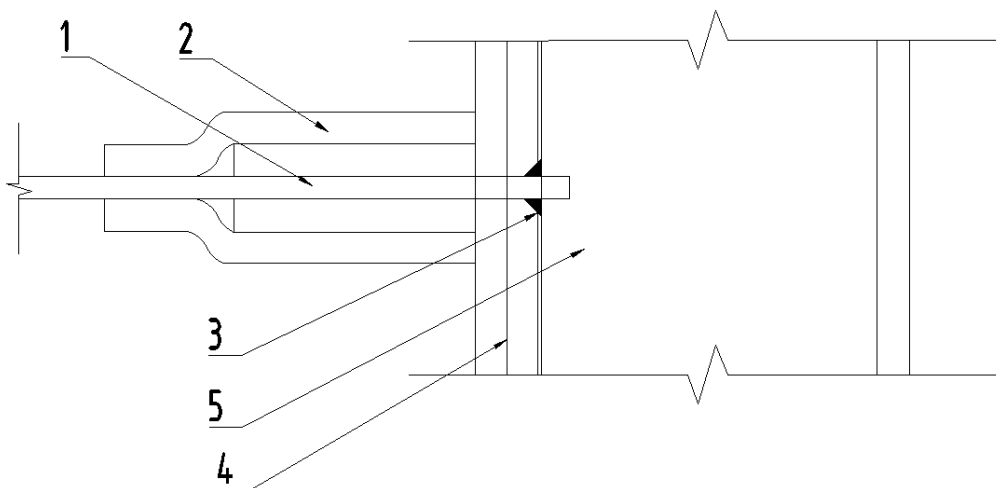


Fig. 12 – Pipe Protection B Details

A Sprinkler head may be installed on the inside of a vertical duct as tested, with a 27mm OD steel pipe penetrating through the duct wrap protection as per the drawing above will achieve a rating of up to -/120/30, provided the following conditions are met:

Table 18: Pipe penetration characteristics

| Item Number | Description |
|-------------|--|
| 1 | <p>Service</p> <ul style="list-style-type: none"> - Sprinkler head fixed within a 40mm aperture within the duct. - 1 x 27mm OD Steel pipe connected to sprinkler head, penetrating through duct wrap |
| 2 | <p>Penetration Protection</p> <p>For Pipe Protection A:</p> <ul style="list-style-type: none"> - One layer of DUCTWRAP-38 wrapped around service, extending 300mm from Duct protection <p>For Pipe Protection B:</p> <ul style="list-style-type: none"> - One layer of DUCTWRAP-38 wrapped around service, extending 300mm from Duct protection - A of DUCTWRAP-38 wrapped around service, extending 300mm from Duct protection |
| 3 | <p>Acrylic sealant</p> <ul style="list-style-type: none"> - 20mm Protecta FR acrylic or FIRESTOP Ultra Acrylic sealant cone installed into Ductwrap Aperture |
| 4 | <p>Firestop Ductwrap</p> <ul style="list-style-type: none"> - 38mm thick duct wrap shall be installed as per duct protection requirements |
| 5 | Air Duct |

Table 19: Pipe penetration Ratings and location

| Pipe Protection | Duct Orientation | Minimum distance from Separating Element | Rating |
|-------------------|------------------|--|----------|
| Pipe Protection A | Vertical | 1425mm | -/120/30 |
| Pipe Protection B | Vertical | 1700mm | -/120/30 |

4.8.3 Steel Channel Support

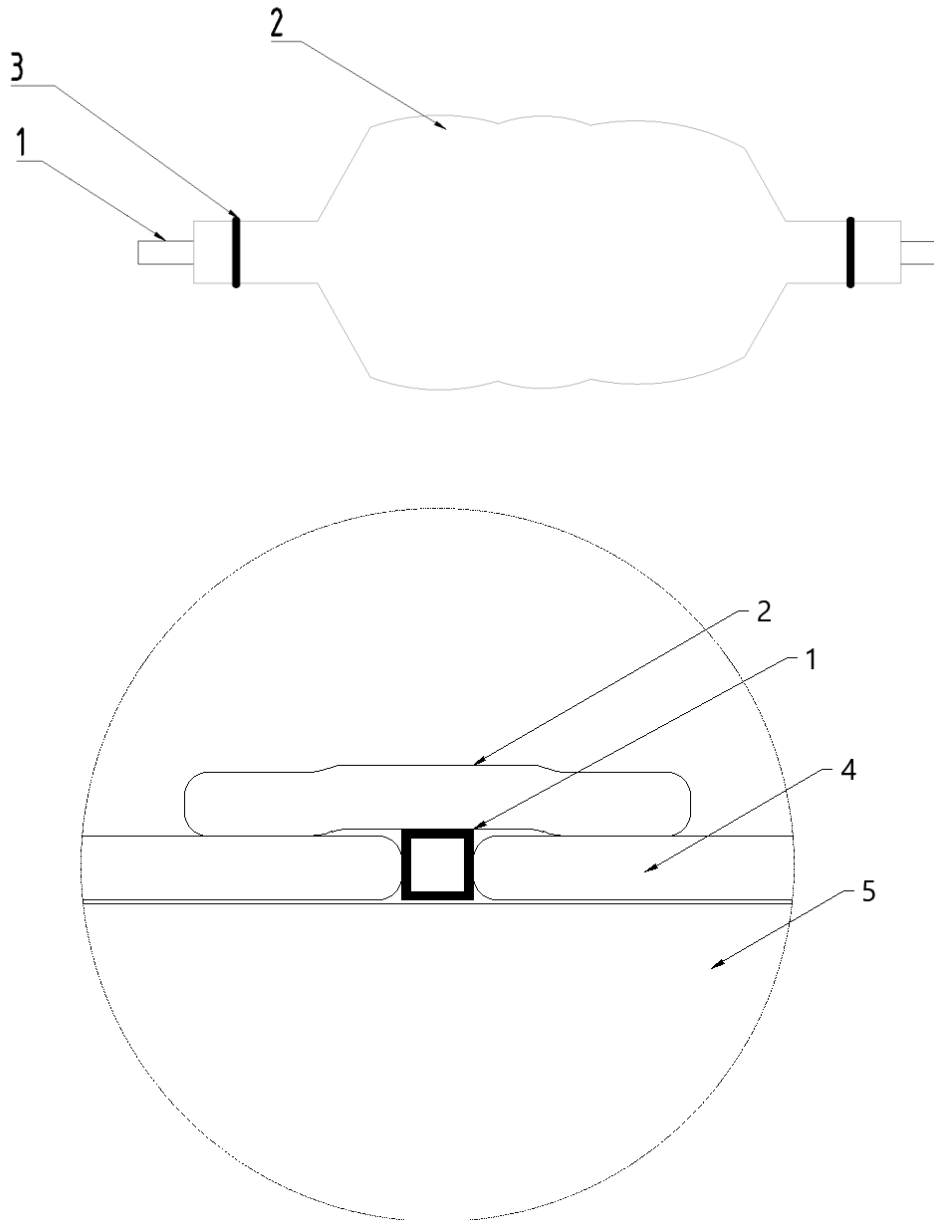


Fig. 13 – Steel Channel support details

Up to two steel channels may be installed on the outside of a vertical or horizontal duct, protected as per the drawing above will achieve a rating of up to -/120/120, provided the following conditions are met

Table 20: Support Channel penetration Characteristics

| Item Number | Description |
|-------------|--|
| 1 | <p>Service</p> <ul style="list-style-type: none"> - 42mm x 42mm Steel channel installed directly to the air duct for support. |
| 2 | <p>Penetration Protection</p> <ul style="list-style-type: none"> - Additional layer of DUCTWRAP-38 to be installed over the top of the steel channel, overlapping by minimum 100mm from all sides of channel. - Where a C-Channel has been used, sections of DUCTWRAP shall be installed within channel, same applied for hollow square sections - Where the channel extends from the duct, DUCTWRAP shall be wrapped around the channel and secured with cable ties. |
| 3 | <p>Fixings</p> <ul style="list-style-type: none"> - Minimum 2 x steel cable ties shall secure the Ductwrap patch to the sections of channel that extend from the duct. |
| 4 | <p>Firestop Ductwrap</p> <ul style="list-style-type: none"> - 38mm thick duct wrap shall be installed as per duct protection requirements. Duct wrap to be butted into channel on both sides of channel |
| 5 | <p>Air Duct</p> |

- The duct dimensions shall not exceed those described above
- The support shall be located not less than 1300mm from the separating element
- The supporting channel dimensions shall not exceed 42 x 42mm

4.9 2- and 3-Side accessible ducts

The following systems may be used in situations where a rectangular duct is located close to a rigid fire-rated separating element and the FIRESTOP Duct Wrap-38 cannot be applied to all sides of the duct as described in other sections of the report provided that the Firestop Ductwrap-38 creates a fully closed system for the full length of the duct.

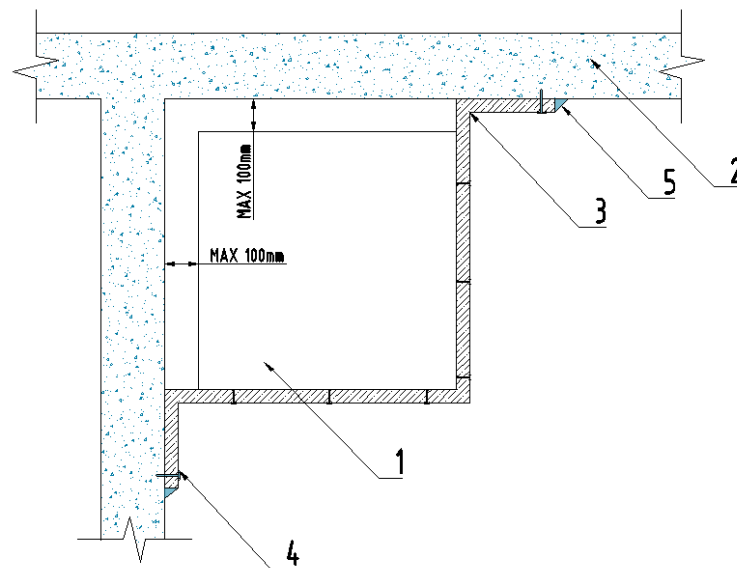


Fig. 14 – 2-side Exposure Details

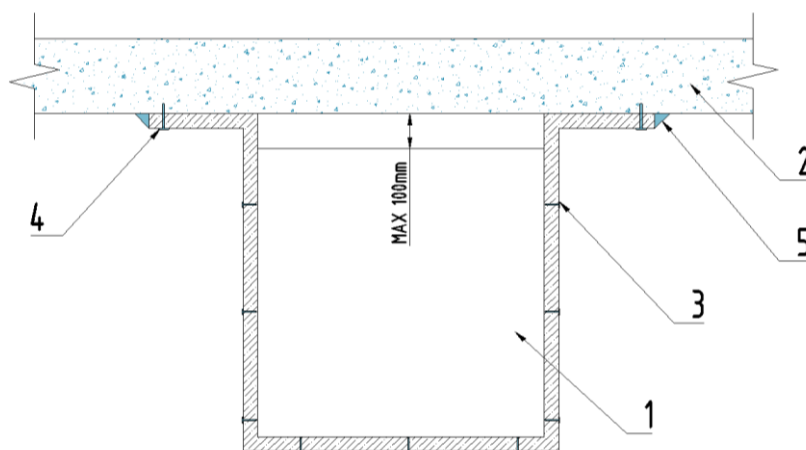


Fig. 15 – 3-side Exposure Details

The 2 and 3 side exposure cases as above may be implemented for both internal and external fire conditions, provided the following conditions are met:

Table 21: 2 and 3-Side exposure Characteristics

| Item Number | Description |
|-------------|--|
| 1 | Air Duct Up to 120/120/120 <ul style="list-style-type: none"> - Located maximum 100mm from separating element |
| 2 | Separating Element Up to 120/120/120: <ul style="list-style-type: none"> - minimum 150mm thick concrete floor - minimum 120mm thick concrete wall |
| 3 | Ductwrap <ul style="list-style-type: none"> - Firestop DUCTWRAP-38 installed to 2 or 3 sides of the duct. Edges of ductwrap overlap onto the separating element by minimum 100mm on all applicable sides - Ductwrap to be fixed with Welded pins only - Number of layers of ductwrap shall be in accordance with the required FRL found in table 5, 7,9 or 11. |
| 4 | Fixings <ul style="list-style-type: none"> - Fixed to separating element using concrete anchors and washers at 200mm centres |
| 5 | Sealant <ul style="list-style-type: none"> - FIRESTOP Ultra Acrylic or Protecta FR Acrylic sealant cone installed between ductwrap and separating element |

- Penetration detail A or B shall be used
- The wrap protection characteristics shall be consistent with requirements of Tables 7, 9, 11 or 13 coinciding with the desired FRL
- The spacing between the duct and separating element shall be no more than 100mm at any point
- The wrap shall be fixed to the concrete separating element with minimum 100mm overlap. The wrap shall be fixed using concrete anchors and washers (OD > 25mm) at 200mm centres

5. Validity of the Assessment

The assessment report is valid till 09/08/2028.

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

This Assessment does not provide an endorsement by Fire TS Lab of the actual data provided.

The conclusions of this report may be used to directly assess the fire resistance performance under such conditions, but it should be acknowledged that a single test method will not provide a full assessment of the product under all fire conditions.

Because of the nature of fire resistance testing and the consequential difficulty in quantifying the uncertainty of measurement, it is not possible to provide a stated degree of accuracy. The inherent variability in testing procedures, materials and methods of construction and installation may lead to variations in performance between elements of similar construction.

This Assessment can only, therefore, relate to the actual prototype test specimens, testing conditions and methodology provided in the supporting data and does not imply any performance abilities of constructions of subsequent manufacture.

This Assessment is based on the information provided and experience available at the time of writing. The published procedures for the conduct of tests and the assessment of test results are subject to constant review and improvement and it is recommended that this document be reviewed on or before the stated expiry date. If contradictory evidence becomes available to the assessing authority, the assessment will be unconditionally withdrawn and the report sponsor will be notified in writing. Similarly, the assessment should be re-evaluated, if the assessed construction is subsequently tested since actual test data is deemed to take precedence.

The information contained in this document shall not be used for the assessment of variations other than those in the conclusions above. This document is valid providing no modifications are made to the systems described in this document.

All details of construction should be consistent with the requirements stated in the relevant test reports and all referenced documents.

6. Authority

By using this document as evidence of compliance of performance, the applicant(s) confirms that;

- to their knowledge the component or element of structure which is the subject of this assessment has not been subjected to a fire test to the standard against which this assessment is being made, and;
- they agree to withdraw this assessment from circulation should the component or element of the structure be subject to a fire test by a recognized test authority in accordance with the standard against which this assessment is being made and the results are not in agreement with this assessment and;
- they are not aware of any information that could adversely affect the conclusions of this assessment and if they subsequently become aware of any such information agree to ask the testing authority to withdraw the assessment.

This assessment may only be reproduced in full without modifications by the sponsor. Copies, extracts or abridgements of this report in any form shall not be published by other organisations or individuals without the permission of Fire TS Laboratory.

Appendix A – Discussion

Penetration details A and C

Internal fire tests PF23004, PF23083, PF23095, and PF24048 comprised of both vertically and horizontally orientated, circular and rectangular ducts passing through various separating elements, including plasterboard-steel stud, plasterboard-timber stud and concrete separating elements. In this range of tests, the penetration protection was installed as a one-way system.

Throughout the range of tests, the penetration detail was installed using the same methods and materials and tested for up to 120 minutes as described in Appendix B.

Test PF23004 included an 800mm x 800mm horizontally orientated duct, penetrating through a timber stud and 2 x 13mm FR plasterboard wall. No structural adequacy, integrity or insulation failures were observed at either the separating element or on the penetration detail collar during the 127-minute test.

Test PF23083 included a 1000mm x 500mm horizontally orientated duct, penetrating through a steel stud and 1 x 13mm FR plasterboard wall. No structural adequacy or integrity failures were observed at either the separating element or on the penetration detail collar during the 124-minute test. Thermocouples attached to the separating element and the penetration detail collar exceeded the insulation criteria at approximately 70 minutes, which occurred after the published -/60/60 fire resistance level of the separating element.

Test PF24048 included an 1800mm x 400mm vertically orientated duct, penetrating through a 150mm concrete slab. No structural adequacy, integrity or insulation failures were observed at either the separating element or on the penetration detail collar during the 126-minute test.

Test PF23110 included an 800mm diameter horizontally orientated duct, penetrating through a 76mm steel stud and 1 x 13mm FR plasterboard wall. No structural adequacy or integrity failures were observed at either the separating element or on the penetration detail collar during the 124-minute test. Thermocouples attached to the separating element and the penetration detail collar exceeded the insulation criteria at approximately 60 minutes, which occurred after the published -/60/60 fire resistance level of the separating element. In the opinion of the laboratory, the thickness of the separating element was deemed to be the cause of insulation failure. Therefore, it is likely that an increase in separating element specification to 2 x 13mm FR Plasterboard layers installed to each side of a 92mm steel frame would achieve an FRL of up to -/120/120.

The one-way penetration detail demonstrated its ability to achieve an FRL of up to -/120/120 minutes in both horizontal and vertical orientations for a range of duct sizes and separating elements. It was observed that the only instances of insulation failure of the penetration detail occurred after the published FRL of the separating element. It is considered reasonable and conservative that the fire resistance of proposed

penetration details A (Fig.1) and C (Fig.3) is likely to achieve at least the rating stated for the respective separating element if tested in accordance with AS1530.4-2014.

The two-way penetration details follow the same installation method as the one-way protection, however an additional FR Board collar is to be installed on one side, making it a symmetrical installation. It is likely that the installation of an additional FR Board collar would not negatively influence the performance of the system, and therefore the two-way protection is also likely to achieve at least the rating stated for the respective separating element if tested in accordance with AS1530.4-2014.

In External Fire test PF24010-1, Penetration detail A was installed as a two-way system was installed to a 1000x500mm duct penetrating through a 120mm concrete floor. No structural adequacy, integrity or insulation failures were observed at either the separating element or on the penetration detail collar during the 124-minute test, demonstrating the ability of penetration A to achieve an FRL of up to -/120/120 when exposed to an external fire.

Penetration detail B

In the internal fire resistance test PF23082, the duct was tested passing through a 64mm steel stud wall with one layer of fire-rated plasterboard on each side. The temperature recorded by the thermocouple located on the plasterboard wall exceeded the limiting temperature at 58 minutes while the thermocouple located on the board collar exceeded the limiting temperature at 70 minutes. The insulation failure was determined by the performance of the wall, which likely influenced the temperature recorded on the board collar. There was no integrity failure recorded at the conclusion of the test at 91 minutes.

Based on the above discussion, it is considered reasonable and conservative that the fire resistance of proposed penetration detail B (Fig.2) is likely to achieve at least -/60/30 FRL if tested in accordance with AS1530.4-2014 in the separating elements, having higher fire resistance performance, such as steel stud wall with higher profile of the stud, timber stud framed walls with stud profile not less than 64mm or minimum 90mm concrete walls.

It is considered reasonable and conservative that the fire resistance of proposed penetration detail B (Fig.2) is likely to achieve at least -/90/60 FRL if tested in accordance with AS1530.4-2014 in the separating elements, having higher fire resistance performance, such as steel or timber stud framed walls with minimum 64mm stud and at least two layers of 13mm fire rated plasterboard each side or minimum 120mm concrete walls.

It is considered conservative, that penetration detail will demonstrate the same or better performance if tested in the concrete separating element, provided the thickness of the concrete is the same or greater thickness than the equivalent plasterboard wall.

The two-way penetration details follow the same installation method as the one-way protection, however an additional FR Board collar is to be installed on one side, making

it a symmetrical installation. It is likely that the installation of an additional FR Board collar would not negatively influence the performance of the system, and therefore the two-way protection is also likely to achieve at least the rating stated for the respective separating element if tested in accordance with AS1530.4-2014.

Penetration Detail D

In the internal fire resistance test PF24072, the vertically orientated duct was tested passing through a 120mm concrete slab. The aperture was measured to be 840mm x 840mm, while the circular duct was measured to be 800mm diameter. This resulted in an annular gap ranging from 20mm to 170mm. At the conclusion of the test, no integrity or insulation failures were recorded on the separating element or on the FR Board. Penetration Detail D demonstrated its ability to achieve an FRL of up to -/120/120 when installed to a minimum 120mm concrete floor if tested in accordance with AS1530.4-2014.

In the opinion of the laboratory, if the penetration detail described in section 1.1.4 were installed to a circular duct of a smaller diameter than that tested in PF24072, the penetration detail is likely to achieve an FRL equivalent to that of PF24072 provided that the annular gap is in the range of 20mm -170mm.

To ensure that the steel collar can be fixed to the separating element as described in section 1.1.4, the steel collar shall overlap onto the separating element by a minimum of 45mm at four edges of the separating element. In the case where the minimum aperture size is greater than 30mm, the thickness of the steel angle collar shall be increased to 2mm. Furthermore, to ensure that the FR Board can be installed correctly as described in section 1.1.4, the annular gap between the duct and the aperture shall not be less than 20mm.

In the opinion of the laboratory, if the penetration detail described in section 1.1.4 were installed to a rectangular duct penetrating through a rectangular aperture, the penetration detail is likely to achieve an FRL equivalent to that of PF24072.

Penetration detail D was tested vertically in a concrete separating element. The maximum temperature recorded on the separating element or on the penetration detail during the tests was 101 °C at 124 minutes. In the opinion of the laboratory, the heat transfer through the separating element and penetration detail would not be significantly affected if the duct orientation was changed from vertical to horizontal. It is considered conservative and reasonable that if penetration detail D was installed to a wall of equal or greater thickness than tested, the integrity and insulation performance of the system would not be reduced.

Penetration Detail E

In the external fire resistance test PF24010-2, the vertically orientated duct was tested passing through a 120mm concrete slab. The aperture was measured to be 860mm x 860mm, while the circular duct was measured to be 800mm diameter. This resulted in an annular gap ranging from 30mm to 200mm. At the conclusion of the test, no integrity or insulation failures were recorded on the separating element or on the FR Board. Penetration Detail E demonstrated its ability to achieve and FRL of up to -/120/120 when installed to a minimum 150mm concrete floor if tested in accordance with AS1530.4-2014.

The maximum temperature recorded on the separating element or on the penetration detail during the tests was 68°C at 110 minutes. In the opinion of the laboratory, the heat transfer through the separating element and penetration detail would not be significantly affected if the duct orientation was changed from vertical to horizontal. It is considered conservative and reasonable that if penetration detail E was installed to a wall of equal or greater thickness than tested, the integrity and insulation performance of the system would not be reduced.

Alternative Sealant

Throughout the range of tests, Penetration details A, C and E used Protecta FR Acrylic Sealant, while penetration detail D used FIRESTOP Ultra Acrylic Sealant. It was proposed that these sealants could be used interchangeably.

A technical analysis of the performance of each of these sealants was conducted. In test PF23004, an 800mm x 800mm duct was tested penetrating through a timber stud and 2 x 13mm FR plasterboard wall. The internal aperture of the separating element was lined with additional plasterboard, then was protected using Penetration Detail A. The 20-30mm annular gap between the duct and the separating element was packed with approximately 100mm of ceramic fibre, then 20mm depth of Protecta FR Acrylic Sealant was installed on each side. A steel angle collar and Protecta FR Board collar was installed on both faces. Protecta FR Acrylic Sealant was installed between board – Separating element, Steel angle – Duct, board – steel angle and board – wrap. The penetration detail demonstrated the ability to maintain integrity and insulation for up to 127 minutes.

In test PF24072, an 800mm diameter duct was tested passing through a concrete floor separating element. Penetration detail D was used for the penetration protection; therefore, Protecta FR Boards were installed within the 20-170mm annular gap. A steel angle collar and Protecta FR Board collar was installed on both faces of the separating element. FIRESTOP Ultra Acrylic Sealant was installed between board – Separating element, Steel angle – Duct, board – steel angle and board – wrap. The penetration detail demonstrated the ability to maintain integrity and insulation for up to 125 minutes.

The most significant difference between the penetration details is the annular gap protection, where penetration detail D is considered to be more onerous. The minimum thermal resistance was calculated for both annular gap protections at ambient temperature, based on manufacturer reported technical details. Both sealants are reported to have similar expansion rates during fire conditions and similar thermal conductivities. For penetration detail A, the minimum thermal resistance was approximately $2\text{m}^2\cdot\text{K}/\text{W}$. For penetration detail D, the minimum thermal resistance was approximately $1.1\text{m}^2\cdot\text{K}/\text{W}$. While the thermal resistance of penetration detail D is considerably lower than that of penetration detail A, both systems maintained integrity and insulation criteria for up to 120 minutes.. It is considered reasonable and conservative that the substitution of Protecta FR Acrylic Sealant for FIRESTOP Ultra Acrylic Sealant would not significantly influence the performance of Penetration A, C or E, and that the penetration detail would likely maintain the integrity and insulation performance achieved by each penetration detail.

Therefore, in the opinion of the laboratory, the substitution of Protecta FR Acrylic Sealant for FIRESTOP Ultra Acrylic Sealant in Penetration Detail A, C and E can be positively assessed, however the reverse shall not apply.



Wrap protection

In the fire resistance tests PF23004, PF23082, PF23095, PF23110, PF24048, PF24010-1, PF24010-2 and PF24072 the duct was tested using single and double layers of 38mm thick FIRESTOP WRAP. The tests were conducted for 60, 90 and 120 minutes as described in Appendix B. All ducts were designed in accordance with AS4254.2 Pressure class 500. AS1530.4 section 9 states that the structural adequacy failure of the duct shall be deemed to have occurred when the duct collapses in such a manner that the duct no longer fulfils its intended function. AS1530.4 section 9 states that the Integrity of the duct shall be deemed to be lost for internal fire testing, when hot gases can pass to the unexposed side, except for the open end; and for external and internal fire testing, under the criteria given in Section 10 for service penetrations.

During the range of tests, no failures were observed in terms of structural adequacy or integrity, displaying the ability of the 500 Pressure class duct to withstand internal fire exposure for up to 120 minutes. Although unlikely, structural adequacy could be compromised if the supporting system of the internal duct were to be affected by the temperature of the wrap. The maximum temperature recorded at any point on a single layer of wrap was below 400 °C, which is not likely to significantly influence the supporting system of the duct. Based on this, it is considered reasonable and conservative that the fire resistance performance of the tested duct sizes for the internal fire will achieve 120 minutes of structural adequacy and integrity if protected with 1 layer of duct wrap if tested to AS1530.4-2014.

In the fire resistance test PF23083, a 1000 x 500mm horizontally oriented duct was tested for a duration of 124 minutes. The duct had one layer of 38mm thick wrap installed along the entire length of the duct, with a 600mm wide second layer wrap installed butted against the separating element. A reinforced aluminium tape was used for all joints, overlaps and cut ends. The thermocouple located at a wrap overlap, 700mm from the separating element exceeded the insulation failure criteria of 180K at 33 minutes. The structural adequacy and integrity failure criteria were not exceeded at the conclusion of the test. It was observed that the tape became detached from the wrap prior to the insulation failure of the wrap, which likely allowed hot air generated on the outer surface of the duct through convection to escape from the wrap joints.

There was no observation of internal duct hot gasses penetrating through the duct, therefore the integrity of the duct was not compromised. It is however, likely that the specimen thermocouples were significantly influenced by the hot air, which resulted in higher temperatures along the entire length of the duct compared to other similar tests. In the opinion of the laboratory, the use of reinforced tape negatively influenced the performance of the test, and the results shall not be used to further examine the insulation performance of the wrap protection.

In the fire resistance tests PF23004 and PF23082, various sizes of horizontally oriented ducts were tested. The ducts had one layer of the wrap applied to the entire length of the duct, with additional sections of wrap for assessment of the second layer's performance.

It was observed, that the single layer of 38mm thick wrap achieved up to 30 minutes insulation criteria, while two layers of 38mm wrap achieved up to 120 minutes insulation criteria. The exception to this is where thermocouples were located in the proximity of the separating element and the duration of the test exceeded the stated performance of the separating element, resulting in the thermocouples being affected by the hot gases passing through the separating element. AS 1530.4 clause 2.2.3.1 states that if the unexposed face thermocouples become heated by hot gases passing through the specimen then data from that thermocouple shall be excluded – therefore results were disregarded.

For the range of tests, the single layer of the wrap demonstrated its ability to maintain a temperature rise not higher than 180K for 60 minutes at a distance of 1400mm and 90 minutes at a distance of 1800mm from the separating element. Based on analysis of the performance of single and double layers of the wrap, it is likely, that the tested ducts will achieve a minimum of 60 minutes insulation criteria with a second layer of wrap extending 1400mm from the separating element and a minimum of 90 minutes insulation criteria with a second layer of wrap extending 1900mm from the separating element – provided the following criteria are met:

- The penetrated separating element shall have an FRL equal to or greater than that of the duct system
- The duct size shall be limited to a maximum CSA of 1800000mm²
- All wrap joints must overlap by a minimum of 100mm

In the fire resistance test PF23095, an 800 x 800mm vertical duct was tested for a duration of 66 minutes. The duct had one layer of 38mm thick wrap installed along the entire length of the duct, with a 600mm wide second layer wrap installed butted against the separating element. An additional layer of the wrap was installed along the length of one side of the duct to evaluate the performance of the double layer.

The thermocouple located at a transverse joint, 1200mm from the separating element exceeded the insulation failure criteria of 180K at 21 minutes. It was determined that the failure occurred due to the absence of the required wrap overlap of 100mm between the layers and was therefore influenced by hot gasses passing through the gap. The thermocouples located 200mm above and below the stated location were not influenced by hot gasses and did not exceed the insulation failure criteria prior to 30 minutes, therefore results were disregarded.

Apart from the localised insulation failure, it was observed that the single layer of 38mm thick wrap achieved up to 30 minutes insulation criteria, while two layers of 38mm wrap achieved up to 60 minutes insulation criteria.

The single layer of the wrap demonstrated its ability to maintain a temperature rise not higher than 180K for 60 minutes at the distance of 1900mm from the separating element. Based on analysis of the performance of single and double layers of the wrap, it is likely, that the tested ducts will achieve a minimum of 30 minutes insulation criteria with a second layer of wrap extending 600mm from the separating element and a minimum of 60 minutes insulation criteria with a second layer of wrap extending 1900mm from the separating element - provided the following criteria are met:

- The penetrated separating element shall have an FRL equal to or greater than that of the duct system
- The duct size shall be limited to a maximum CSA of 0.64m²
- All wrap joints must overlap by a minimum of 100mm

In the fire resistance test PF23110 an 800mm diameter, horizontally oriented circular duct was tested. The duct had one layer of the wrap installed along the entire length of the duct. An additional layer of the wrap was installed along the length of one side of the duct to evaluate the performance of a double layer.

It was observed, that the single layer of 38mm thick wrap achieved up to 30 minutes insulation criteria, while two layers of 38mm wrap achieved up to 120 minutes insulation criteria.

The single layer of the wrap demonstrated its ability to maintain a temperature rise not higher than 180K for 60 minutes at the distance of 1900mm from the separating element and 90 minutes at the distance of 4300mm from the separating element. Based on analysis of the performance of single and double layers of the wrap, it is likely, that the tested duct will achieve a minimum of 60 minutes insulation criteria with a second layer extending 1900mm from the separating element, 90 minutes insulation criteria, having at least 4300mm of the second layer of wrap and 120 minutes insulation criteria, having at least 4550mm of the second layer of wrap - provided the following criteria are met:

- The penetrated separating element shall have an FRL equal to or greater than that of the duct system
- The duct size shall be limited to a maximum diameter of 1000mm
- All wrap joints must overlap by a minimum of 100mm

In the fire resistance test PF24048, an 1800 x 400mm vertical duct was tested for the duration of 126 minutes. The duct had one layer of 38mm thick wrap installed along the entire length of the duct. An additional second layer with a 1000mm width was installed on top of the first layer along the entire length of the duct, butted against the FR Board. An additional third layer with a 200mm width and 1000mm length was installed on top of the second layer, butted against the FR Board

It was observed, that the single layer of 38mm thick wrap achieved up to 22 minutes insulation criteria, while two and three layers of 38mm wrap achieved up to 120 minutes insulation criteria.

The single layer of the wrap demonstrated its ability to maintain a temperature rise not higher than 180K for 30 minutes at the distance of 1200mm from the separating element.

While a thermocouple was not present at the location, it is considered reasonable that the wrap would maintain a temperature rise not higher than 180K at 30 minutes at a distance of 900mm, provided that 1000mm widths of wrap were used. This is due to the overlap beginning at 900mm, which is likely to provide a temperature similar to that recorded by the thermocouple at 980mm. Based on analysis of the performance of single, double and triple layers of the wrap, it is likely, that the tested duct will achieve a minimum of 30 minutes insulation criteria, with a second layer extending 900mm from the separating element. The tested duct will likely achieve a minimum of 60 minutes insulation criteria with a second layer of wrap extending 1780mm from the separating element and a third layer of wrap extending 860mm from the separating element. The tested duct will likely achieve a minimum of 120 minutes insulation criteria with a second layer of wrap extending 2040mm from the separating element and a third layer of wrap extending 1660mm from the separating element - provided the following criteria are met:

- The penetrated separating element shall have an FRL equal to or greater than that of the duct system
- The duct size shall be limited to a maximum CSA of 1800000mm²
- All wrap joints must overlap by a minimum of 100mm

In the fire resistance test PF24072 an 800mm diameter, vertically oriented circular duct was tested. The duct had one layer of the wrap installed along the entire length of the duct. An additional layer of the wrap was installed 2000mm along the length of one side of the duct to evaluate the performance of a double layer. An additional layer of the wrap was installed 1000mm along the length of one side of the duct to evaluate the performance of a triple layer.

It was observed, that the single layer of 38mm thick wrap achieved up to 26 minutes insulation criteria, while two and three layers of 38mm wrap achieved up to 120 minutes insulation criteria.

The single layer of the wrap demonstrated its ability to maintain a temperature rise not higher than 180K for 30 minutes at the distance of 1600mm from the separating element. The single layer of the wrap demonstrated its ability to maintain a temperature rise not higher than 180K for 60, 90 and 120 minutes at the distance of 2100mm from the separating element. Based on analysis of the performance of single and double layers of the wrap, it is likely, that the tested duct will achieve a minimum of 30 minutes insulation criteria with a second layer extending 1600mm from the separating element. It is likely that the tested duct will achieve a minimum of 120

minutes insulation criteria with a second layer extending 2100mm from the separating element - provided the following criteria are met:

- The penetrated separating element shall have an FRL equal to or greater than that of the duct system
- The duct size shall be limited to a maximum diameter of 800mm
- All wrap joints must overlap by a minimum of 100mm

Duct Suspension

During tests PF24010-1 and PF24010-2, the duct systems were supported by M10 threaded rods and 40 x 40 x 2.4mm trapeze angles, in accordance with AS 4254.2. A pair of supports was fixed to the furnace enclosure above the ducts, spaced approximately 1500mm apart. During tests PF24066-1 and PF24066-2, the duct systems were supported at 1800mm apart. At the conclusion of the tests, the support systems remained in place and the structural adequacy and integrity of the duct were not compromised. This demonstrated the suspension system's ability to withstand 120 minutes of exposure to fire while supporting a 1000mm x 500mm rectangular duct and an 800mm diameter circular duct. AS4254.2 Appendix C includes trapeze load calculations for a given duct size. The bending stress of the trapeze member was calculated to be 6.5N/mm². Neither AS1530.4 or AS4254.2 provide further guidance on the support system under fire conditions, therefore the field of application in EN 1366-1:2014 was considered. EN 1366-1:2014 states that as the test configuration does not allow an assessment of the load bearing capacity, the suspension devices shall be made and sized such that the calculated stresses do not exceed the values given below:

| Type of Load | Maximum Stresses (N/mm ²) 60 < T ≤ 120 min |
|--|---|
| Tensile stress in all vertically orientated components | 6 |
| Shearing stress in screws of property class 4.6 | 10 |

The horizontal load bearing component of the suspension device shall be of the same profile as in the test. It shall be sized in such a way that the bending stress does not exceed that applied to the equivalent member in the test.

In the opinion of the laboratory the support system of the duct is likely to provide structural adequacy for up to 120 minutes provided the vertical components of the suspension system shall not exceed 6 N/mm², shear stress in screws shall not exceed 10 N/mm², and the bending stress of the trapeze member shall not exceed 6.5 N/mm²

Maximum Duct Dimensions

AS 1530.4 states that test results obtained for the largest air duct in the range may be applied to all air ducts of the same type (including any aspect ratio), provided the maximum dimensions do not exceed those tested and that the components remain in the same orientation as that tested. This would allow for a duct size up to 1800mm x 1800mm, however due to the unpredictable nature of fire resistance tests and lack of evidence to support an increase of this size, the more conservative field of direct application highlighted in EN 1366-1:2014 was considered.

EN 1366-1:2014 describes standard sizes in a standard configuration for ducts to be tested, in which the field of direct application may be applied to. Standard configuration "Duct B" describes either a 1000mm wide, 250mm high rectangular duct or a 630mm diameter circular duct which is exposed to fire internally through two openings on each side of the duct, measuring a total area of 50% of the internal cross section of the duct. Although differences between standards are evident, the internal fire exposure highlighted in AS1530.4 is considered to be more onerous than that of EN1366-1, and therefore the field of application is likely to be applicable to ducts tested in accordance with AS1530.4.

The field of applications allows a test result obtained for the standard sizes of duct A and duct B is applicable up to the maximum nominal internal sizes given below.

| | Rectangular Width mm | Rectangular Height mm | Circular Diameter mm |
|-----------|-------------------------|--------------------------|-------------------------|
| Duct Size | 1250 | 1000 | 1000 |

For ducts tested at a size other than those specified above, no extrapolation to larger sizes allowed, however smaller sizes are covered. For ducts larger than the allowable upper limits for extrapolation, no extrapolation to larger sizes is allowed.

In tests PF23082 and PF24048, an 1800 x 400mm rectangular duct was tested both vertically and horizontally, and demonstrated the ability to maintain structural adequacy and integrity for up to 120 minutes. As the width of the duct is larger than the allowable upper limits for extrapolation it shall not be increased. The height however is smaller than the maximum height specified above.

In tests PF23110 and PF24072, a 800mm diameter circular duct was tested both vertically and horizontally, and demonstrated the ability to maintain structural adequacy and integrity for up to 120 minutes. The diameter is smaller than the maximum diameter specified above.

Therefore, in the opinion of the laboratory, an increase of duct dimensions of up to 1800mm x 1000mm for rectangular ducts and up to 1000mm diameter for circular ducts is not likely to negatively influence the performance of the duct for up to 120 minutes.



In the opinion of the laboratory, the performance of the duct may be applied to all air ducts of the same type (including any aspect ratio), provided the area of the duct does not exceed the limits described above and that the components remain in the same orientation as that tested. Therefore, rectangular duct sizes, limited by a maximum cross-sectional area of 1800000mm² have been positively assessed. Ducts with dimensions within the plotted area of Figure 4 above, provided the duct has been constructed in accordance with AS4254.2 Pressure class 500 or higher. Similarly, circular ducts, limited by a maximum diameter of 1000mm have been positively assessed, provided the duct has been constructed in accordance with AS4254.2 Pressure class 500 or higher.

In test PF24010-1, a rectangular duct measuring 1000 x 500mm was installed using penetration detail A in a concrete separating element and was tested for 120 minutes, protected by 2 layers of wrap. During the test, there was no evidence of structural adequacy, integrity or insulation failure. The maximum temperature recorded within the duct was recorded to be 152°C, and the temperatures on the unexposed side of the test were significantly lower than the same duct tested in an internal fire environment. For this reason, the internal fire conditions are considered more onerous. In the opinion of the laboratory, if the duct size was increased to a maximum CSA of 1800000mm, it is likely that the performance of the duct would not be negatively influenced and would achieve an FRL of 120/120/120, provided the following conditions are met:

- An airflow of 1m/s shall be maintained
- Penetration Detail A shall be used
- 2 layers of wrap shall protect the external fire section of the duct
- If an internal fire section exists, it shall be protected in accordance with the tables above.
- The duct shall be constructed in accordance with AS4254.2
- The support system shall be in accordance with the maximum allowable stresses listed above.

In test PF24010-2, a circular duct measuring 800mm diameter was installed using penetration detail C in a concrete separating element and was tested for 120 minutes, protected by 2 layers of wrap. During the test, there was no evidence of structural adequacy or integrity failure. Insulation failure inside the duct occurred at 93 minutes, however the temperatures on the unexposed side of the test were significantly lower than the same duct tested in an internal fire environment. For this reason, the internal fire conditions are considered more onerous. In the opinion of the laboratory, if the duct size was increased to a diameter of 1000mm, it is likely that the performance of the duct would not be negatively influenced and would achieve an FRL of 120/120/90, provided the following conditions are met:

- An airflow of 1m/s shall be maintained
- Penetration Detail C shall be used
- 2 layers of wrap shall protect the external fire section of the duct

- If an internal fire section exists, it shall be protected in accordance with the tables above.
- The duct shall be constructed in accordance with AS4254.2
- The support system shall be in accordance with the maximum allowable stresses listed above.

Wrap fixings, overlap and joint treatment

In the fire resistance tests PF23004, PF23082, PF23083, PF23095 and PF23110 the ducts were tested using various methods of wrap fixings, overlaps and joints.

Throughout the range of tests, different wrap joining methods were used between layers of wraps. It was observed that regardless of the type of joint (except for butt joint with no overlap), the joint did not influence the structural adequacy, integrity or insulation. Therefore, it was confirmed that the joints with at least 100mm overlap will not negatively influence the overall performance of the duct wrap protection and are likely to achieve at least the performance stated in this assessment. The allowable wrap overlaps are detailed in section 4.4.1

Throughout the range of tests, different joint tapes were applied to the cut ends of the wrap and applied between wrap joints. It was observed that regardless of the type of tape, the joint tape did not influence the structural adequacy or integrity of the system. The joint tape did however significantly influence the insulation performance of the systems. In test 23083, reinforced aluminium tape was used for all joints, overlaps and cut ends. It was observed that the tape became detached from the wrap prior to insulation failure of the wrap, likely due to the reinforcing fibres within the tape contracting. Due to this, different joint tapes used in the test were grouped into three classes:

- Class 1: Minimum 50µm thick Aluminium tape with minimum 120°C heat-resistant adhesive. No reinforced aluminium tape is allowed.
- Class 2: Minimum 50µm thick Aluminium tape with minimum 60°C heat-resistant adhesive. No reinforced aluminium tape is allowed.
- Class 3: No tape or any reinforced aluminium tape

It was observed that 30 minutes insulation can be achieved using class 1 or 2 solid aluminium foil tape for the treatment of cut edges and any foil tape (class 1, 2 or 3) may be used for wrap joints.

It was observed that 60 minutes insulation can be achieved using class 1 or 2 solid aluminium foil tape for the treatment of cut edges and wrap joints.

It was observed that 90- and 120-minute insulation can be achieved using class 1 solid aluminium foil tape for the treatment of cut edges and wrap joints.

In the fire resistance test PF23004 an 800x800mm horizontally orientated duct was tested. The wrap was secured to the duct using 12mm wide stainless-steel straps. The straps were located at 300mm centres and each overlap, 50mm from the ends of the wrap. It was confirmed that the welded pins were installed with tolerance of +/-30mm for the installation to the main body and +/-15mm for the edges. Those tolerances did not jeopardise the performance of the protection. At the conclusion of the test, there was no structural adequacy or integrity failure of the system. It was observed that there

was minor sagging at the bottom of the wrap, but no dislocation of the wrap between layers at 120 minutes.

In fire resistance test PF23082 a 1800x400mm horizontally orientated duct was tested. The wrap was secured to the duct using 12mm wide stainless-steel straps, as well as glued stainless-steel pins. The straps were located at 300mm centres and each overlap, 50mm from the ends of the wrap. It was confirmed that the welded pins were installed with tolerance of +/-30mm for the installation to the main body and +/-15mm for the edges. Those tolerances did not jeopardise the performance of the protection. At the conclusion of the test, there was no structural adequacy or integrity failure of the system. It was observed that the pins had become detached from the duct at 5 minutes, and there was sagging at the bottom of the wrap, but no dislocation of the wrap between layers at 90 minutes. The use of the pins did not affect the performance of the system and may be omitted.

In the fire resistance tests PF23083, PF23095 and PF23110, the wrap was installed to the ducts using capacitive discharge welded pins. The pins were installed at nominal 200mm centres around the width and length of the duct, and nominal 50mm from the ends of the wrap. It was confirmed that the welded pins were installed with tolerance of +/-30mm for the installation to the main body and +/-15mm for the edges. Those tolerances did not jeopardise the performance of the protection. A range of pin lengths were tested, depending on how many layers of wrap were in the required location. The wrap shall be compressed by the pin. If too long of a pin is used, the pins do not secure the wrap to the duct sufficiently near the corners. If too short of a pin is used, the wrap foil becomes damaged during the welding process. The minimum and maximum lengths for pins can be seen in the table below. The standard wrap thickness and pin lengths are advertised in inches and have been conservatively converted for the purpose of this assessment.

| Thickness of Ductwrap used | Pin length (minimum) | Pin length (maximum) |
|----------------------------|----------------------|----------------------|
| 1 x 38mm | 25mm | 40mm |
| 2 x 38mm | 63mm | 80mm |
| 3 x 38mm | 95mm | 120mm |

At the conclusion of the test, there was no structural adequacy or integrity failure of the system. There was no sagging or dislocation between wraps observed.

Based on the above discussion it is considered reasonable that the wrap protection will achieve a similar or better rating for internal fire protection if tested in accordance with AS1530.4-2014 and fixed using the following methods:

Horizontal orientation:

Up to 800 x 800mm - steel straps and/or welded pins

Up to 300mm diameter - steel straps and/or welded pins

Vertical orientation:

Up to 300 x 300mm - steel straps and/or welded pins

Up to 300mm diameter - steel straps and/or welded pins

For ducts exceeding the above dimensions, welded pins shall only be used

Where steel straps are to be used, the straps shall be minimum 12mm wide and 0.15mm thick. The steel straps shall be installed at 300mm centres, as well as 50mm from the ends of all layers of wrap.

Where welded pins are to be used, steel or copper-plated steel pins with a diameter of 2.5mm – 3.2mm shall be used. Different lengths of pins shall be used depending on the thickness of the wrap, in accordance with the table below. Pins shall be fixed at maximum 200mm centres along the width and length of the duct and shall be fixed 50mm from the ends of all layers of wrap.

Access hatch

In the fire resistance test PF23004 an 800 x 800mm horizontally orientated rectangular duct was tested, which included a FIRESTOP Access hatch installed over a 600x450mm opening. During the test, no integrity or insulation failure was observed. The hatch demonstrated the ability to achieve an FRL of up to -/120/120 when located at a distance of 1800mm from the separating element and installed in accordance with Appendix B.

In the fire resistance test PF23095 an 800 x 800mm the vertically orientated rectangular duct was tested, which included a FIRESTOP Access hatch installed over a 600x450mm opening. During the test, no integrity failure was observed. The hatch failed insulation at 60 minutes. The hatch demonstrated the ability to achieve an FRL of up to -/60/60 when located at a distance of 1075mm from the separating element and installed in accordance with Appendix B.

In the fire resistance test PF24048, an 1800 x 400mm vertically orientated rectangular duct was tested, which included a reduced size FIRESTOP Access hatch installed over a 440x320mm opening. During the test, no integrity failure was observed. The hatch failed insulation at 71 minutes, from a thermocouple that was installed on one layer of wrap. Thermocouples located on 2 layers of wrap did not fail the insulation criteria. The hatch demonstrated the ability to achieve an FRL of up to -/120/60 when located at a distance of 1330mm from the separating element and installed in accordance with Appendix B.

In the fire resistance test PF24072, an 800mm diameter vertically orientated circular duct was tested, which included a reduced size FIRESTOP Access hatch installed over a 440x320mm opening. The hatch base was modified to be mounted to a circular duct, and was additionally protected using a FR Board collar to fill the hatch base recess evenly. During the test, no integrity or insulation failure was observed. The hatch demonstrated the ability to achieve an FRL of up to -/120/120 when located at a distance of 880mm from the separating element and installed in accordance with Appendix B.

In the opinion of the laboratory, it is likely that if the additional protection used in test PF24072 was installed to a vertically oriented hatch installed to a rectangular duct, the performance of the system would not be reduced, and would likely achieve an FRL of up to -/120/120 when located at a distance of 880mm from the separating element. Furthermore, it is likely that the duct tested in PF24048 was protected using an additional 2nd layer around on the remaining two sides, the hatch would have achieved an FRL of up to -/120/120.

In the opinion of the laboratory, it is likely that the installation of hatches using a 600 x 450mm cutout to horizontally orientated ducts, located a minimum of 1800mm from the separating element will not negatively influence the performance of the system, and is likely to achieve an FRL of up to -/120/120. It is likely that the installation of access hatches to vertically orientated ducts, located a minimum of 1075mm from the separating element will not negatively influence the performance of the system, and is



likely to achieve an FRL of up to -/60/60. It is likely that a reduction in aspect ratio of the access hatch will not negatively influence the performance of the hatch, provided the following criteria are met:

- Hatches shall be protected with minimum one layer of wrap butting into the recess, with an additional layer of wrap installed around the hatch, extending 100mm from all edges
- The dimensions of the hatch shall not exceed 650mm x 450mm
- The width and length of the hatch may be reduced, but not the thickness of the hatch or part thereof
- Individual components shall not be removed or reduced in size
- The hatch flanges shall overlap and be fixed to on all edges around the cut-out
- The hatch shall be located not less than 100mm from any edge of the duct
- The fixing centres shall not be increased

In the opinion of the laboratory, it is likely that the installation of hatches using a 440 x 320mm cut out to horizontally orientated ducts, located a minimum of 1800mm from the separating element will not negatively influence the performance of the system, and is likely to achieve an FRL of up to -/120/120. It is likely that the installation of access hatches to vertically orientated ducts, located a minimum of 880mm from the separating element will not negatively influence the performance of the system, and is likely to achieve an FRL of up to -120/120. It is likely that a reduction in aspect ratio of the access hatch will not negatively influence the performance of the hatch, provided the following criteria are met:

- A Protecta FR Board collar shall be installed around the perimeter within the hatch recess
- Hatches shall be protected with minimum one layer of wrap butting into the recess, with an additional layer of wrap installed around the hatch, extending 100mm from all edges
- The dimensions of the hatch shall not exceed 440mm x 320mm
- The width and length of the hatch may be reduced, but not the thickness of the hatch or part thereof
- Individual components shall not be removed or reduced in size
- The hatch flanges shall overlap and be fixed to on all edges around the cut-out
- The hatch shall be located not less than 100mm from any edge of the duct
- The fixing centres shall not be increased

Duct Support Penetration

In test PF24072, an 800mm diameter vertically orientated duct was installed penetrating through a 120mm concrete slab. The duct was supported by two steel channels fixed directly to the duct at 1300mm from the separating element. The channels were protected using one layer of wrap installed butting up to the channels. A trimmed 610mm x 1000mm wrap was used to encase the supporting channel so that the protection was wrapped around both sides of the support by 200mm. The wrap was fixed to the duct using welded pins, and fixed to the channel using steel ties. Additional thermocouples were installed around the channel penetration for assessment purposes. The channel penetration protection demonstrated the ability to maintain insulation and integrity for up to 120 minutes. In the opinion of the laboratory, it is likely that this method of protecting steel channels used to support the duct will maintain insulation and integrity for up to 120 minutes for all circular and rectangular ducts in either vertical or horizontal orientation, provided the following conditions are met:

- The duct dimensions shall not exceed those described above
- Channel protection shall be installed as described above
- The support shall be located not less than 1300mm from the separating element
- The supporting channel dimensions shall not exceed 42 x 42mm
- The number of supporting channels at any given cross section of the duct shall be limited to a maximum of 2

Single Cable penetration

In test PF24072, an 800mm diameter vertically orientated duct was installed penetrating through a 120mm concrete slab. The duct was protected using one layer of 38mm wrap along the entire length of the duct. A single TPS cable was installed along the duct, which then penetrated through the single layer section of the wrap at 1300mm from the separating element. The cable penetration was protected by a 200mm x 150mm patch was installed around the cable. The hole created by the penetration was sealed with FIRESTOP Ultra Acrylic Sealant.

Additional thermocouples were installed around the cable penetration for assessment purposes. The cable penetration protection demonstrated the ability to maintain insulation and integrity for up to 120 minutes. In the opinion of the laboratory, it is likely that this method of protecting a single cable penetrating through the wrap will maintain insulation and integrity for up to 120 minutes for all circular and rectangular ducts in either vertical or horizontal orientation, provided the following conditions are met:

- The duct dimensions shall not exceed those described above
- Cable protection shall be installed as described above
- The penetration shall be located not less than 1300mm from the separating element
- The protection is only applicable to a single TPS cable



- In areas where the cable penetrates through two layers of wrap, an additional 200mm x 150mm patch shall still be installed.

2- and 3- Sides accessible ducts

During the range of tests, the ability of the duct protection to achieve an FRL of up to 120/120/120 was displayed. In some cases, the installation of the wrap protection on all 4 sides may not be possible due to clearances between the separating element and duct. For this reason, 2-side and 3-side exposure for rectangular ducts installed parallel to concrete separating elements were considered. In the opinion of the laboratory, the use of wrap protection 2 or 3 side exposure is not likely to negatively influence the performance of the system for both internal and external flaming conditions, provided the following conditions are met:

- Penetration detail A or B shall be used
- The wrap protection characteristics shall be consistent with requirements of Tables 7, 9, 11 or 13 coinciding with the desired FRL
- The spacing between the duct and separating element shall be no more than 100mm at any point
- The wrap shall be fixed to the concrete separating element with minimum 100mm overlap. The wrap shall be fixed using concrete anchors and washers (OD > 25mm) at 200mm centres

Appendix B – Supporting Data

Test PF23004

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – Internal fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 10/05/2023.

An 800mm x 800mm (W/H) air duct was installed, penetrating through a 90x45mm timber stud wall, with 2 x layers of FR plasterboard on each side. The supporting construction aperture was protected using a combination of acrylic sealant, ceramic fibre, steel brackets, and FR board. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using steel cable ties. The first layer of wrap was installed to the entire length of the duct. The second layer of wrap extended approximately 1100mm from the separating element protection. All joints were overlapped by minimum 100mm.

The duct included a FIRESTOP Access hatch installed over a 600x450mm opening, located 1800mm from the separating element. The hatch was fixed directly to the duct using rivets around the perimeter in the corresponding mounting holes, at 150mm centres. One layer of 38mm duct wrap was installed around the hatch butting into the hatch webbing. All joints on the first layer of wrap were butt joints. An additional layer of wrap was installed around the perimeter of the hatch, extending 100mm from all edges of the hatch.

The test was terminated at 127 minutes. No structural adequacy or integrity failure was observed during the test. The duct failed insulation criteria at 62 minutes on the 1st layer of wrap at 1400mm distance from the separating element. The thermocouples associated with the hatch did not reach failure criteria during the test.

The following temperature measurements were recorded for the determination of the effective thickness of protection:

| Layers of wrap | From the wall, mm | Maximum temperature rise, deg C | | | |
|----------------|-------------------|---------------------------------|--------|--------|---------|
| | | 30 min | 60 min | 90 min | 120 min |
| 1 | 1200 | 82 | 177 | 228 | 240 |
| | 1200 | 64 | 161 | 189 | 197 |
| 2 | 25 | 37 | 120 | 166 | 180 |
| | 25 | 17 | 69 | 170 | 178 |
| | 400 | 30 | 105 | 152 | 155 |
| | 400 | 16 | 66 | 129 | 133 |
| | 1900 | 59 | 119 | 141 | 157 |
| | 1900 | 59 | 132 | 150 | 149 |

Test PF23082

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – Internal fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 10/05/2023.

An 1800mm x 400mm (W/H) duct was installed, penetrating through a 64mm steel stud wall, with 1 x layer of 13mm fire-rated plasterboard on each side. The supporting construction aperture was protected using a combination of intumescent sealant, steel brackets, FR board and acrylic sealant. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using steel cable ties and glued steel pins. One layer of wrap was installed to the entire length of the duct. All joints were overlapped by minimum 100mm. Additional thermocouples were installed on the overlaps, resulting in the measurement of 2 layers of wrap in some locations.

The test was terminated at 91 minutes. No structural adequacy or integrity failure was observed during the test. The duct failed insulation criteria at 33 minutes on the 1 layer of the wrap at a 1200mm distance from the separating element.

The following temperature measurements were recorded for the determination of the effective thickness of protection:

| Layers of wrap | From the wall, mm | Maximum temperature rise, deg C | | | |
|----------------|-------------------|---------------------------------|--------|--------|---------|
| | | 30 min | 60 min | 90 min | 120 min |
| 1 | 100 | 92 | 215 | 302 | N/A |
| | 500 | 134 | 238 | 270 | N/A |
| | 1200 | 79 | 185 | 209 | N/A |
| | 1400 | 69 | 172 | 195 | N/A |
| | 1800 | 40 | 110 | 131 | N/A |
| 2 | 600 | 42 | 101 | 143 | N/A |
| | 1300 | 7 | 50 | 79 | N/A |

Test PF23083

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – Internal fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 24/11/2023.

A 1000mm x 500mm (W/H) air duct was installed, penetrating through a 64mm steel stud wall, with 1 x layer of FR plasterboard on each side and around the aperture. The supporting construction aperture was protected using a combination of steel brackets, ceramic fibre, FR board and acrylic sealant. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using welded steel pins. A reinforced aluminium foil tape was used to seal all exposed ends of the duct wrap, as well as all overlaps and joints. The first layer of wrap was installed to the entire length of the duct. The second layer of wrap extended approximately 600mm from the separating element protection. The first joint of the first layer was a butt joint and remaining joints were overlapped by minimum 100mm.

The test was terminated at 124 minutes. No structural adequacy or integrity failure was observed during the test. The duct failed insulation criteria at 33 minutes on the 1 layer of the wrap at a 600mm distance from the separating element at the location of the transverse joint of the wrap. It was observed that the reinforced aluminium tape became detached prior to insulation failure, and smoke was coming from multiple overlaps and joints.

The following temperature measurements were recorded for the determination of the effective thickness of protection:

| Layers of wrap | From the wall, mm | Maximum temperature rise, deg C | | | |
|----------------|-------------------|---------------------------------|--------|---------|----------|
| | | 30 min | 60 min | 90 min* | 120 min* |
| 1 | 700 | 117 | 332 | 346 | 362 |
| | 1000 | 97 | 247 | 276 | 289 |
| | 1600 | 111 | 200 | 220 | 242 |
| | 1900 | 29 | 166 | 213 | 235 |
| 2 | 100 | 50 | 142 | 204 | 236 |
| | 400 | 39 | 163 | 187 | 203 |
| | 1500 | 38 | 106 | 125 | 135 |

* - The duct was tested in the separating element having FRL -/60/60, therefore the FRL of the duct was reduced to 60/60/30.

Test PF23095

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – Internal fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 01/12/2023.

An 800mm x 800mm (W/H) air duct was installed vertically, penetrating through a timber joists floor, with 1 x 16mm FR Plasterboard on the exposed face, 1 x 19mm Structural Chipboard on the unexposed face and 13mm FR Plasterboard was installed around the aperture. The supporting construction aperture was protected using a combination of steel brackets, ceramic fibre, FR board and acrylic sealant. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using welded steel pins. The first layer of wrap was installed to the entire length of the duct. The second layer of wrap extended approximately 600mm from the separating element protection. All joints were overlapped by minimum 100mm – To confirm an additional layer of wrap was butt-joined to the second layer on one side, extending the second layer of wrap.

The duct included a FIRESTOP Access hatch installed over a 600x450mm opening, located 1075mm from the separating element. The hatch was fixed directly to the duct using rivets around the perimeter in the corresponding mounting holes, at 150mm centres. One layer of 38mm duct wrap was installed around the hatch butting into the hatch webbing. All joints on the first layer of wrap were butt joints. An additional layer of wrap was installed around the perimeter of the hatch, extending 100mm from all edges of the hatch.

The test was terminated at 66 minutes. No structural adequacy or integrity failure was observed during the test. The duct failed insulation criteria at 21 minutes on the 1 layer of the wrap at 1200mm distance from the separating element at the location of the transverse joint of the wrap. The thermocouples associated with the hatch did not reach failure criteria during the test.

The following temperature measurements were recorded for the determination of the effective thickness of protection:

| Layers of wrap | From the floor, mm | Maximum temperature rise, deg C | | | |
|----------------|--------------------|---------------------------------|--------|--------|---------|
| | | 30 min | 60 min | 90 min | 120 min |
| 1 | 1000 | 150 | 241 | N/A | N/A |
| | 1400 | 156 | 242 | N/A | N/A |
| | 1900 | 126 | 175 | N/A | N/A |
| | 1900 | 87 | 138 | N/A | N/A |
| 2 | 100 | 61 | 165 | N/A | N/A |
| | 400 | 32 | 119 | N/A | N/A |
| | 700 | 19 | 107 | N/A | N/A |
| | 1600 | 17 | 78 | N/A | N/A |



Test PF23110

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – Internal fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 19/12/2023.

An 800mm diameter circular air duct was installed, penetrating through a 76mm steel stud wall with 1 x layer of FR plasterboard on each side. The supporting construction aperture was protected using a combination of steel collars, FR board and acrylic sealant. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using foil tape and welded steel pins. The first layer of wrap was installed to the entire length of the duct. An additional layer of wrap was installed on the left side of the duct, along the entire length of the duct. All joints were overlapped by minimum 100mm

The test was terminated at 125 minutes. No structural adequacy or integrity failure was observed during the test. The duct failed insulation criteria at 31 minutes on the 1 layer of the wrap at 400mm distance from the separating element.

The following temperature measurements were recorded for the determination of the effective thickness of protection

| Layers of wrap | From the board, mm | Maximum temperature rise, deg C | | | |
|----------------|--------------------|---------------------------------|--------|--------|---------|
| | | 30 min | 60 min | 90 min | 120 min |
| 1 | 25 | 176 | 364 | 331 | 373 |
| | 400 | 176 | 300 | 304 | 313 |
| | 850 | 110 | 214 | 233 | 254 |
| | 1100 | 131 | 228 | 244 | 253 |
| | 1750 | 112 | 186 | 203 | 215 |
| | 1900 | 87 | 174 | 208 | 226 |
| | 2500 | 90 | 163 | 194 | 209 |
| | 3400 | 142 | 176 | 189 | 201 |
| | 4300 | 81 | 147 | 169 | 184 |
| | 4550 | 30 | 104 | 133 | 145 |
| 2 | 50 | 41 | 109 | 121* | 132* |
| | 400 | 37 | 78 | 108* | 110* |
| | 800 | 18 | 94 | 105* | 115* |
| | 1700 | 28 | 125 | 166 | 167 |
| | 3150 | 11 | 71 | 108 | 118 |
| | 4200 | 7 | 46 | 82 | 93 |
| | 4550 | 4 | 26 | 57 | 71 |



* - Temperature recorded using roving thermocouple applied for 90 seconds

Test PF24048

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – Internal fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 10/04/2023.

An 1800 x 400mm rectangular air duct was installed vertically, penetrating through a 150mm reinforced concrete slab. The slab aperture was protected using a combination of steel angle brackets, ceramic fibre, FR board, duct wrap, FR Coating and acrylic sealant. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using foil tape and welded steel pins. The first layer of wrap was installed to the entire length of the duct. An additional layer of wrap measuring 1000mm in width was installed along the entire length of the duct on one of the faces, aligned with the edge of the duct to gather data for 2 layers of wrap. An additional layer of wrap measuring 200mm in width, and 1000mm in length was installed on top of the second layer, aligned with the edge of the duct to gather data for 3 layers of wrap. All joints were overlapped by minimum 100mm

The duct included a FIRESTOP Access hatch installed over a 440x320mm opening, located approximately 1330mm from the separating element. The hatch was fixed directly to the duct using rivets around the perimeter in the corresponding mounting holes, at 150mm centres. One layer of 38mm duct wrap was installed around the hatch butting into the hatch webbing. All joints on the first layer of wrap were butt joints. An additional layer of wrap was installed around the perimeter of the hatch, extending 200mm from two of the edges of the hatch. The hatch achieved an FRL of -/120/60. Insulation Failure was recorded by thermocouples attached to the single layer of wrap around the hatch perimeter.

The duct included two sprinkler penetrations, Pipe 1 and 2 located at 1700mm and 1425mm respectively from the separating element. The sprinkler head was installed within the duct and the 27mm OD steel pipe extended minimum 900mm horizontally from the duct, through the duct wrap. Both pipes were protected using a 20 x 20mm sealant cone within the duct wrap. 1 layer of 300mm wide strip of Duct Wrap-38, secured with steel cable ties was installed around each pipe, butting into the duct protection. An additional 1 layer of 500mm wide strip of Duct Wrap-38 was installed around Pipe 2, butting into the duct protection. Both pipe protection methods achieved an FRL of -/120/30. Insulation failure was recorded by thermocouples attached to the double layer of duct wrap, 25mm from the pipe penetration.

The test was terminated at 126 minutes. No structural adequacy or integrity failure was observed during the test. The duct failed insulation criteria at 24 minutes on the first layer of the wrap at 400mm distance from the separating element.

The following temperature measurements were recorded for the determination of the effective thickness of protection:

| Layers of wrap | From the floor, mm | Maximum temperature rise, deg C | | | |
|----------------|--------------------|---------------------------------|--------|--------|---------|
| | | 30 min | 60 min | 90 min | 120 min |
| 1 | 25 | 157 | 265 | 320 | 356 |
| | 400 | 245 | 281 | 318 | 344 |
| | 660 | 252 | 316 | 334 | 367 |
| | 860 | 239 | 313 | 346 | 374 |
| | 980 | 89 | 175 | 200 | 218 |
| | 1200 | 176 | 246 | 285 | 300 |
| | 1440 | 165 | 235 | 249 | 259 |
| | 1660 | 171 | 231 | 272 | 289 |
| | 1780 | 68 | 157 | 175 | 181 |
| | 2040 | 112 | 167 | 190 | 206 |
| 2 | 25 | 35 | 101 | 147 | 193 |
| | 400 | 37 | 184 | 228 | 259 |
| | 660 | 31 | 163 | 202 | 231 |
| | 860 | 47 | 190 | 236 | 273 |
| | 980 | 22 | 120 | 164 | 186 |
| | 1200 | 48 | 165 | 202 | 230 |
| | 1440 | 49 | 175 | 211 | 237 |
| | 1660 | 33 | 128 | 154 | 168 |
| | 1780 | 22 | 122 | 162 | 176 |
| | 2040 | 25 | 84 | 110 | 123 |
| 3 | 25 | 12 | 61 | 97 | 128 |
| | 400 | 7 | 76 | 133 | 154 |
| | 860 | 7 | 81 | 148 | 174 |

Test PF24010-1

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – External fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 16/02/2024.

A rectangular 1000mm x 500mm (W/H) air duct, comprising of a 2100mm horizontal section, two 90-degree angles and two 1800mm vertical sections. The vertical sections penetrated through two corresponding apertures in a 150mm reinforced concrete slab. The slab apertures were protected using a combination of steel angle brackets, ceramic fibre, FR board and acrylic sealant. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using welded steel pins. Two layers of wrap were installed on the exposed side of the duct, with all joints overlapping by minimum 100mm.

The test was terminated at 124 minutes. No structural adequacy, integrity failure or insulation failure was observed during the test.

The following temperature measurements were recorded for the determination of the effective thickness of protection:

| Location | Maximum temperature rise, deg C | | | |
|--|---------------------------------|--------|--------|---------|
| | 30 min | 60 min | 90 min | 120 min |
| Thermocouple inside the duct, attached to the surface of the duct in the furnace | 37 | 86 | 121 | 152 |
| External thermocouples at seal and wrap (non-fire side) | 1 | 7 | 32 | 101 |

Test PF24010-2

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – External fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 16/02/2024.

A circular 800mm air duct which included horizontal and vertical sections and two 90-degree angles. The vertical sections penetrated through two corresponding square apertures in a 150mm reinforced concrete slab. The slab apertures were protected using a combination of slotted steel angle collars, FR board and acrylic sealant. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using welded steel pins. Two layers of wrap were installed on the exposed side of the duct, with all joints overlapping by minimum 100mm.

The test was terminated at 124 minutes. No structural adequacy or integrity failure was observed during the test. Insulation failure occurred at 93 minutes, located inside the duct, within the furnace.

The following temperature measurements were recorded for the determination of the effective thickness of protection:

| Location | Maximum temperature rise, deg C | | | |
|--|---------------------------------|--------|--------|---------|
| | 30 min | 60 min | 90 min | 120 min |
| Thermocouple inside the duct, attached to the surface of the duct in the furnace | 37 | 140 | 174 | 298 |
| External thermocouples at seal and wrap (non-fire side) | 1 | 12 | 31 | 41 |

Test PF24072

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – Internal fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 07/06/2024.

An 800mm diameter circular air duct was installed vertically, penetrating through a 120mm concrete floor. The supporting construction aperture was protected using a combination of steel collars, FR board and acrylic sealant. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using foil tape and welded steel pins. The first layer of wrap was installed to the entire length of the duct. An additional layer of wrap was installed on the left side of the duct, along the entire length of the duct. All joints were overlapped by minimum 100mm.

Two steel channels were fixed to the duct to support the vertical ducts at a distance of 1300mm from the separating element. These were included within the duct wrap and treated as penetrations of the system. One layer of wrap was installed butting up to the channels. A trimmed 610mm x 1000mm wrap was used to encase the supporting channel so that the protection was wrapped around both sides of the support by 200mm. The wrap was fixed to the duct using welded pins, and fixed to the channel using steel ties.

A single TPS cable was installed along the duct, which then penetrated through the single layer section of the wrap at 1300mm from the separating element. The cable penetration was protected by a 200mm x 150mm patch was installed around the cable. The hole created by the penetration was sealed with FIRESTOP Ultra Acrylic Sealant.

A FIRESTOP hatch with a modified base, designed to attach to a circular duct was installed. A 440mm x 320mm aperture was cut from the duct, 880mm from the separating element. The hatch base was fixed to the duct using rivets at 150mm centres. The hatch base was protected using a Protecta FR Board collar, installed into the hatch recess on its edge, resulting in a 60mm perimeter around the hatch, fixed with pig-tail screws. Exposed edges of the board were coated with Protecta FR Coating. One layer of duct wrap was installed butting up to the collar on all edges of the hatch, with an additional second layer on one edge for assessment purposes. A 10x10mm Protecta FR Acrylic Sealant cone was installed between the board and the wrap.

The test was terminated at 125 minutes. No structural adequacy or integrity failure was observed during the test. The duct failed insulation criteria at 31 minutes on the 1 layer of the wrap at 400mm distance from the separating element.

The following temperature measurements were recorded for the determination of the effective thickness of protection

| Layers of wrap | From the board, mm | Maximum temperature rise, deg C | | | |
|----------------|--------------------|---------------------------------|--------|--------|---------|
| | | 30 min | 60 min | 90 min | 120 min |
| 1 | 25 | 126 | 257 | 267 | 307 |
| | 400 | 202 | - | - | - |



| | | | | | |
|---|------|-----|-----|-----|-----|
| | 900 | 191 | 212 | 227 | 237 |
| | 1600 | 94 | 187 | 196 | 202 |
| | 2100 | 93 | 175 | 168 | 173 |
| 2 | 25 | 33 | 94 | 137 | 168 |
| | 400 | 37 | 138 | 146 | 155 |
| 3 | 25 | 18 | 36 | 59 | 87 |
| | 400 | 7 | 53 | 106 | 128 |

Test PF24066-1

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – External fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 21/06/2024.

A circular 800mm air duct was installed horizontally penetrating through a FR plasterboard and 90 x 45mm timber stud wall. 2 x 13mm FR Plasterboard layers were installed on the exposed face, and 1 x 13mm FR Plasterboard layer on the unexposed face. The wall apertures were protected using a combination of slotted steel angle collars, FR board and acrylic sealant. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using welded steel pins. One layer of wrap was installed on the exposed side of the duct, with all joints overlapping by minimum 100mm.

The test was terminated at 74 minutes. No structural adequacy or integrity failure was observed during the test. Insulation failure occurred at 31 minutes, located inside the duct, within the furnace.

The following temperature measurements were recorded for the determination of the effective thickness of protection:

| Location | Maximum temperature rise, deg C | |
|--|---------------------------------|--------|
| | 30 min | 60 min |
| Thermocouple inside the duct, attached to the surface of the duct in the furnace | 179 | 300 |
| External thermocouples at seal and wrap (non-fire side) | 23 | 44 |

Test PF24066-2

The test was conducted as per AS 1530.4-2014 Section 9 Air ducts – External fire and AS 1530.4-2014 Section 10 Service penetrations and control joints on 21/06/2024.

A 1000x500mm rectangular air duct was installed horizontally penetrating through a FR plasterboard and 90 x 45mm timber stud wall. 2 x 13mm FR Plasterboard layers were installed on the exposed face, and 1 x 13mm FR Plasterboard layer on the unexposed face. The wall apertures were protected using a combination of slotted steel angle collars, FR board, duct wrap and acrylic sealant. The duct was protected using 38mm thick FIRESTOP Duct Wrap-38, fixed using welded steel pins. One layer of wrap was installed on the exposed side of the duct, with all joints overlapping by minimum 100mm.

The duct included a FIRESTOP Access hatch installed over a 315x185mm opening, located approximately 1200mm from the separating element. The hatch was fixed directly to the duct using rivets around the perimeter in the corresponding mounting holes, at 150mm centres. FR Board was installed into the hatch recess, with trimmed edges coated in FIRESTOP Ultra Acrylic sealant, and a bead between hatch and duct. One layer of 38mm duct wrap was installed around the duct, butting into the FR Board around the hatch on all edges. All gaps were sealed using FIRESTOP Ultra Acrylic sealant. The hatch achieved an FRL of -/60/30. Insulation Failure was recorded by thermocouples attached on the internal surface of the duct, 25mm from the hatch aperture.

The test was terminated at 74 minutes. No structural adequacy or integrity failure was observed during the test. Insulation failure occurred at 31 minutes, located inside the duct, within the furnace.

The following temperature measurements were recorded for the determination of the effective thickness of protection:

| Location | Maximum temperature rise, deg C | |
|--|---------------------------------|--------|
| | 30 min | 60 min |
| Thermocouple inside the duct, attached to the surface of the duct in the furnace | 179 | 286 |
| External thermocouples at seal and wrap (non-fire side) | 20 | 45 |