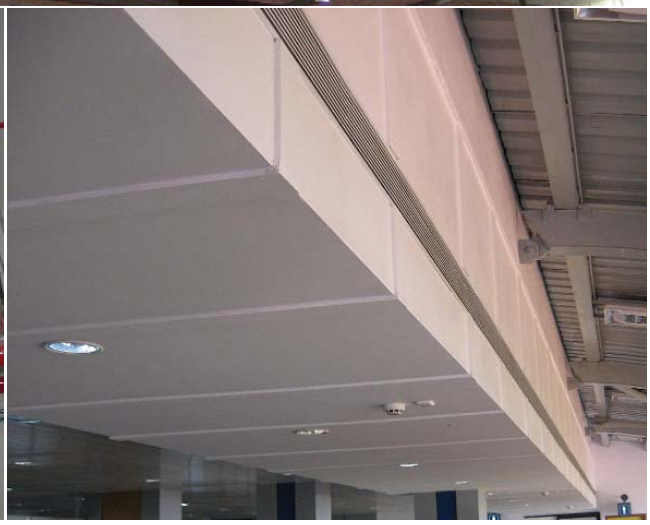
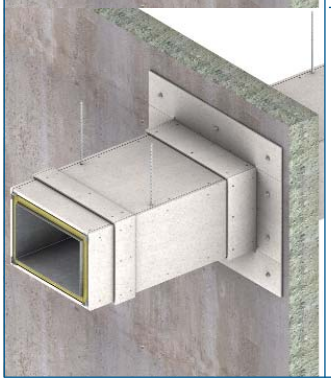
Promat

PROMATECT®-H
Post Cladding Steel Ducts



Type of post cladding steel ducts	System code	FRL	Board thickness	Duct type	Mineral wool	Maximum dimension	Tests and assessments standards/labs	Page no.
	PH 41.12	120/120/-	9mm	A B	Not required	6000mm x 2500mm	BS476: Part 24 and AS1530: Part 4 Report no. • BRE CC82101 • BRE CC89273 • BRE CC89769 • BRE CC93731	7/8
		120/120/30	15mm	A B	Not required	6000mm x 2500mm		
		120/120/60	9mm	A B	50mm x 100kg/m³	6000mm x 2500mm		
		120/120/120	15mm	A B	50mm x 100kg/m³	6000mm x 2500mm		
	PH 41.24	240/240/-	12mm	A B	Not required	6000mm x 2500mm		
		240/240/30	12mm	A B	50mm x 60kg/m³	6000mm x 2500mm		
			20mm	A B	Not required			
		240/240/60	12mm	A B	50mm x 100kg/m³	6000mm x 2500mm		
		240/240/120	12mm	A B	80mm x 100kg/m³	6000mm x 2500mm		
			15mm		50mm x 100kg/m³			
		240/240/240	25mm	A B	2 x 50mm x 100kg/m³	6000mm x 2500mm		

NOTE: For ducts exposed to external fire (Duct type A) the insulation can be measured inside the duct, inside the fire compartment or outside the duct on an adjacent compartment. All the above provide similar levels of insulation to that listed, when the insulation is measured outside the duct. For details of insulated ducts exposed to external fire where insulation is required inside the duct, or inside the fire compartment, please consult Promat Technical Department. Different performance requirements may occur under the Builder Code of Australia (BCA), please consult Promat for clarification if necessary.

The relative complexity of any ductwork system which is passing through different fire compartments and the relevance of the system's function in ambient as well as fire conditions can make the selection of a suitable ductwork system difficult.

This section of the handbook aims to give some guidance on the fire performance requirements of ductwork and offers a wide range of solutions for the protection of steel ductwork and for self-supporting systems using PROMATECT®-H, and PROMATECT®-L500.

For particularly onerous conditions, e.g. where high impact strength is required or for use in aggressive environments, Promat have developed a range of systems using the PROMATECT®-S high impact board.

Fire Testing Methods

To determine the fire resistance of ducts (without the aid of fire dampers) passing through or between compartments, the system should normally be tested or assessed in accordance with BS476: Part 24 or AS1530: Part 4. These standards have been written specifically for ventilation ducts, but guidance is also given in these standards on the performance requirements for "smoke outlet" ducts and "kitchen extract" ducts.

Although the following information refers to BS476: Parts 20 to 24, these details apply equally to AS1530: Part 4 in terms of the performance requirements. It should be noted, however, that there are substantial differences between the two standards in terms of testing methodology which greatly affect the results. It is not possible to simply transfer results from AS1530: Part 4 test to BS476: Part 24 due to this huge difference in testing methods.

A part of a standard fire test, duct systems are exposed to external fire (also known as Duct type A) and one sample to both external AND internal fire (also known as Duct type B). Fans create a standard pressure difference and air flow and the ducts fire performance is assessed in both fan-on and fan-off situations. When testing horizontal ducts, a run of at least 3000mm is located within the fire compartment (the EN and revised ISO standards required a 4000mm length exposed) and a further 2500mm outside the fire compartment.

BS476: Part 24 expresses the fire resistance of ducts without the aid of dampers, in terms of stability, integrity and insulation.

Stability failure occurs when the suspension or fixing devices can no longer retain a duct in its intended position or when sections of the duct collapse. This requirement does not apply to the length of the duct exposed to internal fire (Duct type B) within the fire compartment.

It should be noted that if a duct suffers extensive deformation, such that it can no longer fulfil its intended purpose, this would be classed as stability failure. For Duct type A, loss of pressure within the duct during testing is also construed as stability failure.

Integrity failure occurs when cracks, holes or openings occur in the duct or at any penetrations within walls or floors, through which flames or hot gases can pass. The effects on integrity of the movement and distortion of both restrained and unrestrained ducts are also included in the standard.

Insulation failure occurs when the temperature rise on the outer surface of the duct outside the fire compartment exceeds 140°C (mean) or 180°C (maximum). The guidance in the standard also states that ducts lined with combustible materials or coated internally with fats or greases, e.g. kitchen extract, should also have this criterion for the inner surface of the duct within the fire compartment when the duct is exposed to external fire (Duct A).

For smoke extraction, the guidance in the standard states that the cross sectional area of a duct required to extract smoke in the event of a fire should not be reduced by more than 25% for the duration of the fire exposure.

See **Penetration Through Walls & Floors** on opposite page.

General Design Considerations

The following points are some of the factors which should be considered when determining the correct specification to ensure a ductwork system will provide the required fire performance. Further advice can of course be obtained from the Promat Technical Department.

1. Required Fire Exposure

Ductwork systems which are located in more than one compartment should always be tested or assessed for their performance when exposed to the heating conditions described within BS476: Part 20. Reduced heating curves are generally only acceptable for certain of the systems components, e.g. the fan.

The performance of a ductwork system will vary depending on whether or not a fire could have direct access to inside the duct through an unprotected opening. If in doubt, one should assume direct access, i.e. the Duct B scenario described previously under Fire Testing Methods.

2. Required Fire Performance

It is a general requirement that the ducts must satisfy all the relevant performance criteria of stability, integrity and insulation (and cross sectional area if a smoke extraction duct). However, the approval authority may accept relaxations on occasion. For example, if no combustible materials or personnel could be in contact with the duct, the authority may accept a reduced insulation performance.

General Design Considerations

3. Supporting Structure

Care should be taken that any structural element from which the duct system is supported, e.g. a beam, floor or wall, must have as a minimum the same fire resistance as the duct system itself and must be able to support the load of the duct under fire conditions.

4. Hanger Support

The supporting hangers, supports and their fixings should be capable of bearing the load of the complete ductwork system including any applied insulation material or other services suspended from it. Chemical anchors are generally not considered suitable. It is normally not advisable to use unprotected supports if the stress exceeds the values given on page 5 and/or if hanger lengths exceed 2000mm. The hanger centres should not exceed the limits given in page 5.

5. Steel Ductwork

The steel duct must be constructed in accordance with the requirements of DW/144 – Specification for sheet metal ductwork – low, medium and high pressure/velocity air systems (published by the Heating and Ventilating Contractors' Association UK.), or equivalent specification, e.g. SMACNA. The steel ducts must be constructed with rolled steel angle-flanged cross joints. It is recommend that longitudinal seams be formed using the Pittsburgh lock.

6. Penetrations Through Walls & Floors

Care should be taken to ensure that movement of the duct in ambient or in fire conditions does not adversely affect the performance of the wall, partition or floor, or any penetration seal. It should be understood that where a duct passes through any compartment wall or floor or other type of separating element, the aperture between the element and the duct must be sealed in accordance with the system approved for use with the duct. In general this requires the use of a penetration seal constructed from materials and in such a manner to match the system used in the duct test programme. Penetrations seals are part of the tested duct system and the use of untested third party products are not permitted.

7. Movement Joints

Movement joint details may be required for long lengths of duct, particularly where the duct spans across a movement joint in the floor or wall, or passes through floors and roof that may deflect at different rates. Please consult Promat Technical office for details of such joints.

8. Air Flow & Leakage

The design of some fire resisting duct systems may need modification to meet DW/144 performance standards. All Promat self supporting duct systems will meet the requirements of DW/144 to the highest levels, provided the correct board thickness is employed and all joints are correctly sealed in accordance with the system recommendations.

9. Ductwork Functions

Most ductwork systems can fall into one or more of the following categories:

- Ventilation and air conditioning;
- Natural smoke extract;
- Fan assisted smoke extract;
- Pressurisation of escape routes and fire fighting lobbies.

In the event of a fire, the function of a system can often change. For example, an air conditioning system could switch to become a fan assisted smoke extract duct. It is therefore essential that the performance requirements in both normal conditions and fire conditions are considered.

10. Other Requirements

Acoustic performance, thermal insulation, water tolerance, strength and appearance can also be important considerations (See BS8313: 1989 Code of practice for accommodation of building services in ducts).

Selection of Fire Protection System

Traditionally all ductwork was fabricated from steel which normally had to be encased in a fire protection system when passing through a compartment wall or floor without the aid of a fire damper.

In recent years, self-supporting systems without a steel liner have been introduced to extract smoke in the event of a fire through natural ventilation. Now some self-supporting systems, e.g. PROMATECT®-H, PROMATECT®-L500 and PROMATECT®-S are available which can match the leakage and air flow performance of steel ducts in accordance with the DW144 standard up to Class C.

To satisfy the wide range of requirements in the current market, Promat can offer no less than three products to protect steel ductwork and to fabricate self-supporting systems.

For any size of duct, the tensile stress in the steel hangers must not exceed 10N/mm² for fire resistance up to 120 minutes, or 6N/mm² for fire resistance up to 240 minutes. These figures are based on work carried out by Warrington Fire Research Centre (now Bodycote) in the UK and European research projects into the stress and strains of steel members under simulated fire conditions.

The stress reduction ratio factors mentioned below are based on BS5950: Part 1: 1990. Similar figures can be applied from AS4600.

The method to calculate whether the diameter of the threaded rod is within the permitted stress level is given below.

Fire resistance period	Approximate temperature	Maximum permitted stress	Maximum permitted centres
30 minutes	840°C	18/mm²	2500mm
60 minutes	950°C	10/mm²	2500mm
90 minutes	1000°C	10/mm²	2500mm
120 minutes	1050°C	10/mm²	2500mm
180 minutes	1110°C	6/mm²	2000mm
240 minutes	1150°C	6/mm²	1500mm

It should be noted that the stress levels referred to above apply to the threaded rod hanger supports themselves. The horizontal members have a differing level of applicable stress (see page 5). The maximum centres refers to the greatest allowable distance between hanger support systems. However it should be noted that in certain locations, bends for instance, additional supports at lesser centres should be considered.

Where the hanger support system may exceed the limits given in the table above the remedial options are as follows:

1) Increase the dimensions of the hanger support system, e.g. rod diameters etc,
2) Reduce the centres of the hanger support system,
3) Protect the hanger rods.

Hangers supporting steel ducts protected with Promat materials can be left unprotected providing the maximum stress on each hanger does not exceed the values given in the above table and importantly that their length does not exceed 2000mm. Where hanger rods exceed this dimension, there is a high risk of stability failure of the duct due to excessive expansion of the support system. If hanger rods exceed 2000mm, they should be protected at all times for all systems, regardless of system type or manufacturer.

Stress Calculation For Hangers

To calculate the stress in N/mm² on each hanger, the total weight of the ductwork and fire protection materials being taken by each hanger should be calculated in kilograms, converted to Newtons (N) by multiplying by 9.81 and then divided by the cross-sectional area of the hanger in mm². The cross-sectional area of a circular hanger is $\pi \times r^2$ where r is the radius of the support rod. It should be noted that the root diameter of the threaded rod should be applied in this calculation, not the outer diameter of the thread. Please refer to the table below for details.

The method to calculate whether the diameter of the threaded rod is within the permitted stress level is given below.

Nominal outer diameter	Root diameter	Cross sectional area
6mm	5.06mm	20.10mm²
8mm	6.83mm	36.63mm²
10mm	8.60mm	58.08mm²
12mm	10.36mm	84.29mm²
14mm	12.25mm	117.85mm²
16mm	14.14mm	157.03mm²
18mm	15.90mm	198.55mm²
20mm	17.67mm	245.20mm²

The density of steel is approximately 7850kg/m³, therefore the weight of steel (kg) = 7850 x surface area (m) x steel thickness (m).

The following example of calculating the stress of the support system is based on the use of PROMATECT®-H boards, however, this method would apply to all fire resisting systems.

Board thickness (mm)	=	12
Duct height (m)	=	1.0
Duct width (m)	=	1.0
Centres of hangers (m)	=	1.22
Area of boards	=	(Width x 2) + (Height x 2) x Centres of hangers
Weight of boards	=	Area x Thickness x Density (975kg/m³)
Weight of angles	=	(Centres of hangers x 4) + (Width x 4) + (Height x 4) x 0.63kg/m
Section weight (kg)	=	68.62 (inclusive of angles)
Weight on one hanger	=	34.31
Total force (N)	=	336.58 (Weight (kg) x 9.81 = N)
Diameter of steel rod (mm)	=	8
Cross-section area (mm²)	=	38.63
Stress (N/mm²)	=	$\frac{F}{A}$ where F = force in Newton, where A = area of rod cross section
	=	8.71N/mm²

Since the stress is less than 10N/mm² as set in the table above, an 8mm diameter rod is the minimum permissible for the duct of cross section 1000mm x 1000mm x 1220mm length constructed with a single layer of 12mm PROMATECT®-H. If cladding a steel duct, the weight of this has to be included within the total weight supported upon the hangers.

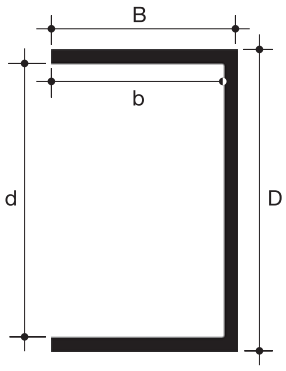
If these stress levels are exceeded then the size of the hanger members must be increased, or the centres of the hangers reduced or the hangers protected. The penetration of the hanger fixings into any concrete soffit should be a minimum of 40mm for up to 120 minutes ratings or 60mm for more than 120 and up to 240 minutes ratings.

To calculate the stress of the horizontal supporting angle of channel, the following would apply.

Board thickness (mm)	=	12
Duct height (m)	=	1.0
Duct width (m)	=	1.0
Centres of hangers (m)	=	1.22
Area of boards	=	(Width x 2) + (Height x 2) x Centres of hangers
Weight of boards	=	Area x Thickness x Density (975kg/m³)
Weight of angles	=	(Centres of hangers x 4) + (Width x 4) + (Height x 4) x 0.63kg/m
Section weight (kg)	=	68.62 (inclusive of angles)
Total force (N)	=	673 (Weight (kg) x 9.81 = N)
Maximum bending Moment, M	=	$\frac{W \times L^2}{8} = 101.79$
Stress, S	=	$\frac{M}{Z} < 19.5$ where Z is the section modulus in cm³
Section modulus, Z	=	$> \frac{M}{19.5}$
Z	=	> 4.7cm³

Using C-channels of uniform thickness in web and flanges, the dimensions of channel:

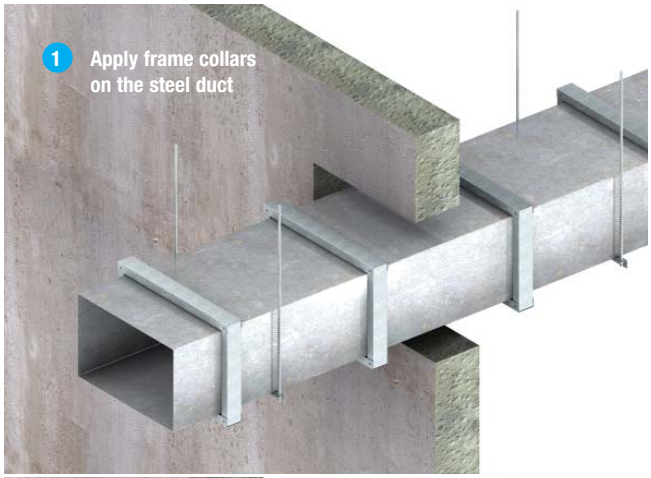
Breath of channel (cm)	=	3
Depth of channel (cm)	=	5
Thickness of channel (cm)	=	0.4
Section modulus	=	$\frac{BxD^2}{6} - \frac{bxd^2}{6}$
	=	4.9cm³

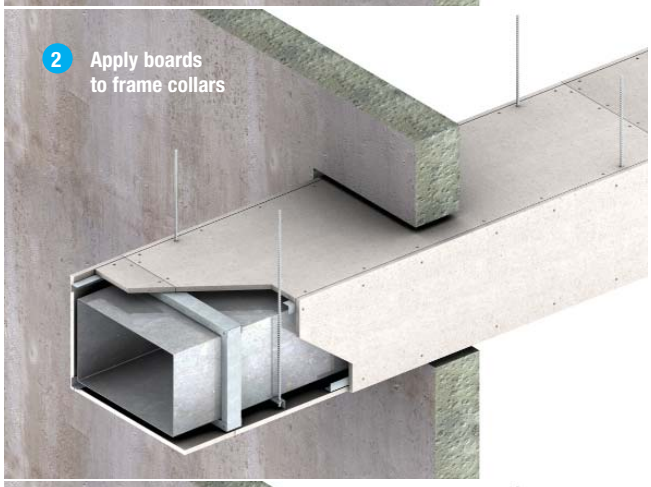


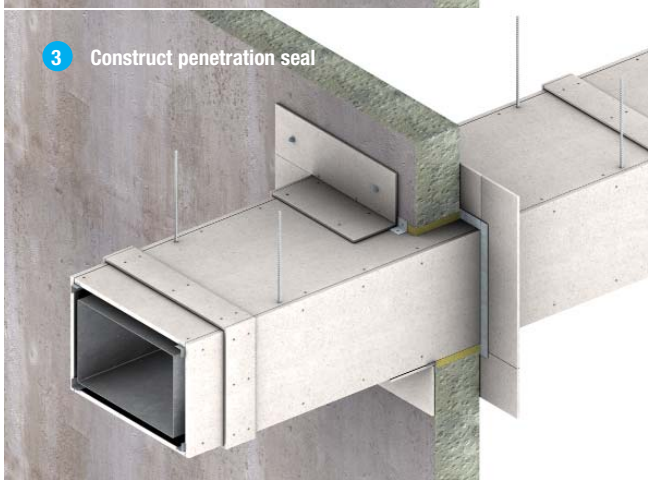
Promat

Post Cladding Steel Ducts
Typical Examples of Installation Steps

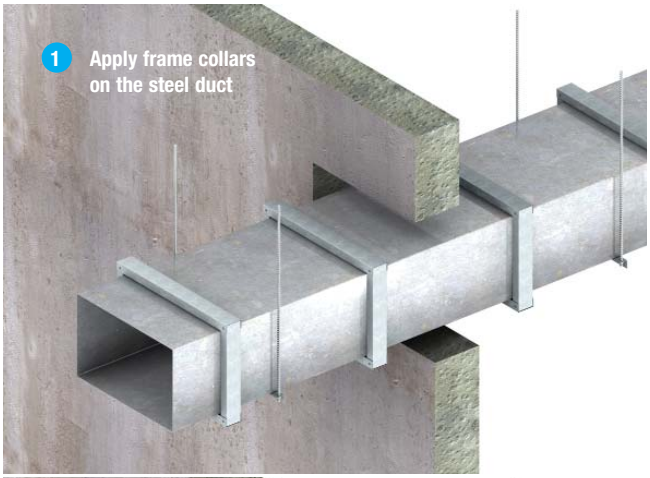
Integrity Only

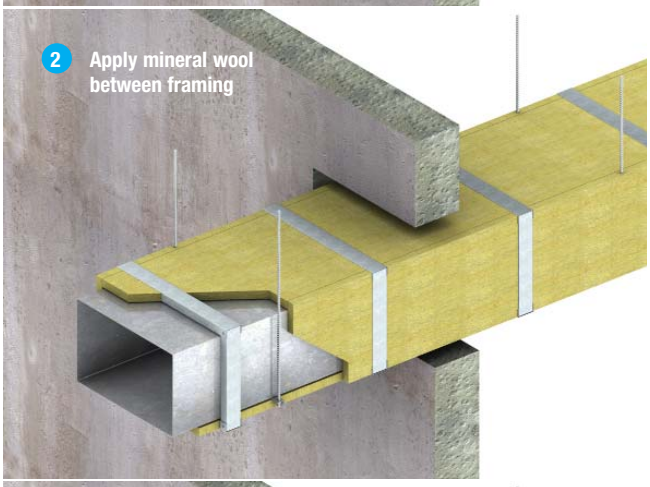


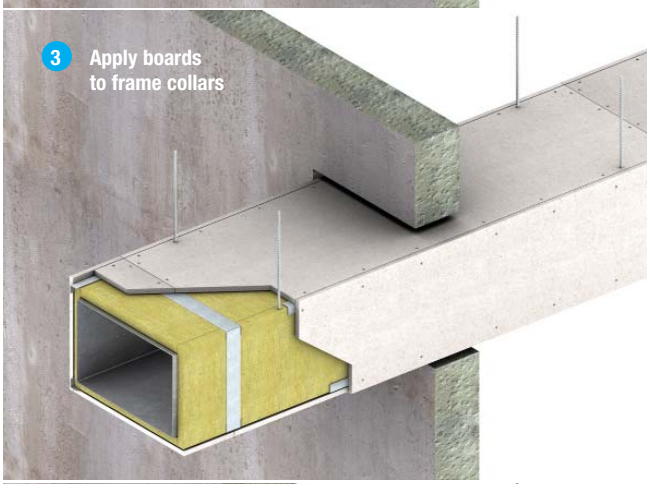


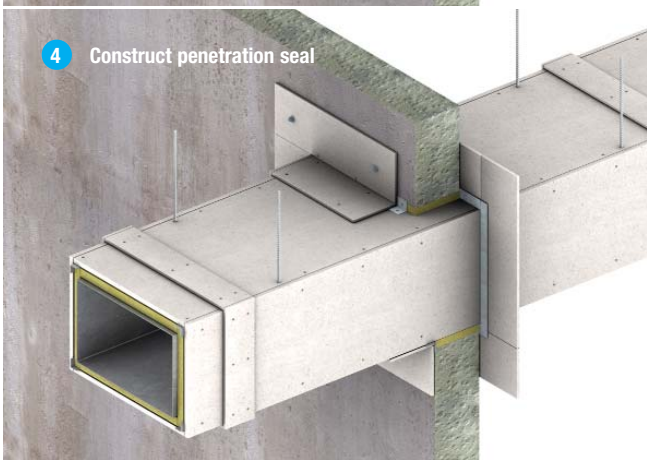


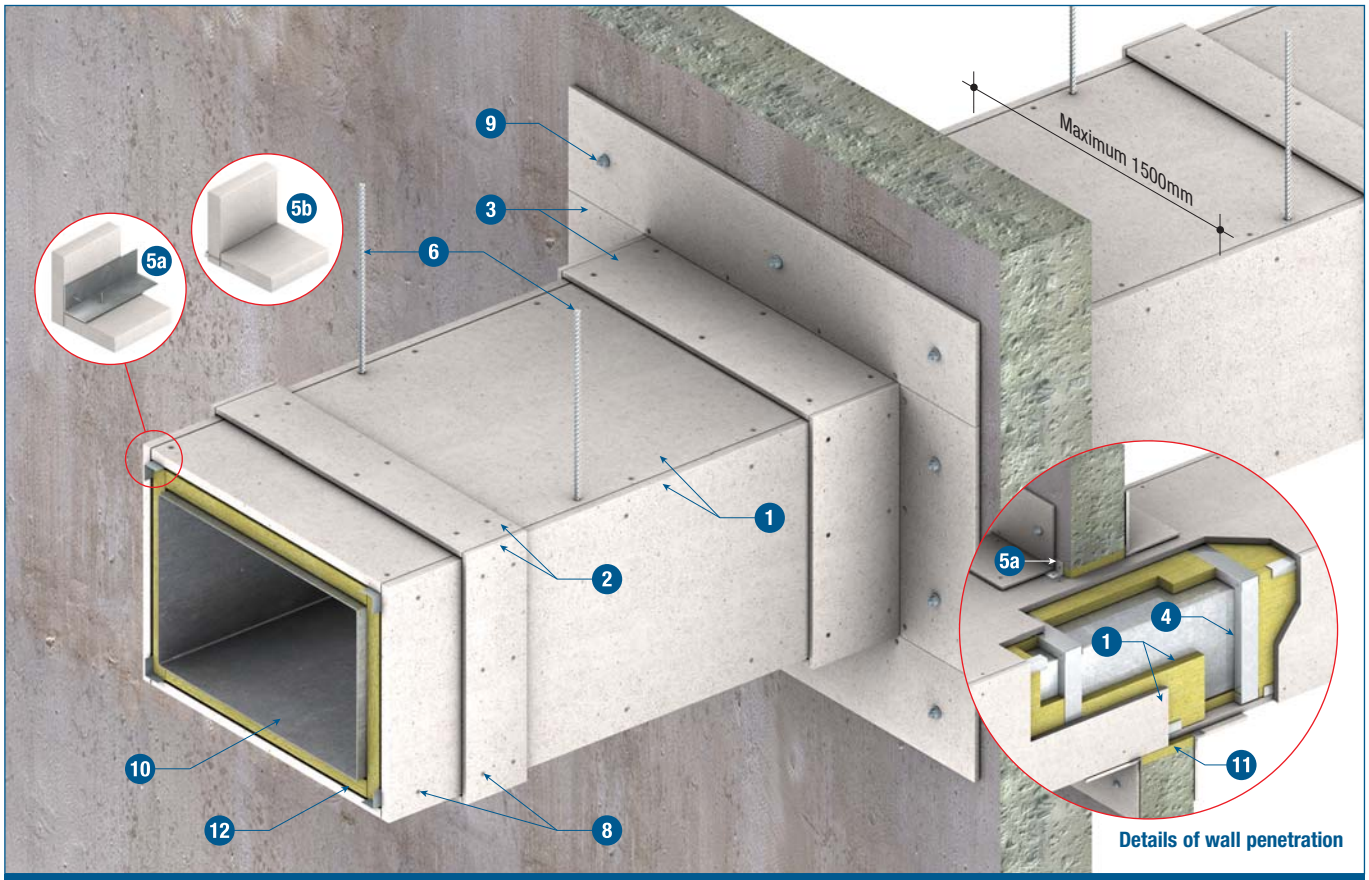
Integrity & Insulation









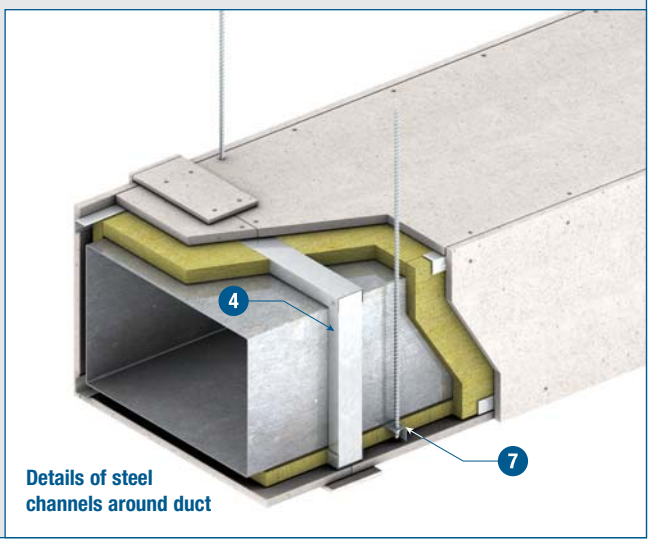


Details of wall penetration

TECHNICAL DATA

1. 1 layer of PROMATECT®-H board, see page 2 for details.
   - For FRL of 120/120/- 9mm thick
   - For FRL of 120/120/30* 15mm thick
   - For FRL of 120/120/120* 15mm thick with 1 layer of mineral wool 50mm x 100kg/m³
   - For FRL of 240/240/- 12mm thick
   - For FRL of 240/240/120* 15mm thick with 1 layer of mineral wool 80mm x 100kg/m³
   - For FRL of 240/240/240* 25mm thick with 2 layers of mineral wool 50mm x 100kg/m³ each
2. 1 layer of PROMATECT®-H cover strips, 100mm wide x board thickness according to the desired FRL.
3. 1 layer of PROMATECT®-H collars, 150mm wide x board thickness according to the desired FRL, fitted around the duct on both sides on the wall forming an L-shape.
4. Steel channels minimum 50mm x 25mm x 0.5mm thick at butt joints
5a. Steel angles 30mm x 30mm x 0.6mm thick or
5b. Screw boards face to edge using deep threaded screws with a minimum 25mm penetration (for boards 20mm or greater thickness)
6. Duct hanger system, stress calculation according to page 5.
7. Steel angles minimum 30mm x 30mm x 3mm thick according to duct weight and size and maximum permitted stress levels
8. No.8 self-tapping screws at nominal 200mm centres or steel wire staples 28/10/1mm at nominal 100mm centres
9. M6 anchor bolts at nominal 600mm centres
10. Mild steel ventilation duct
11. 1 layer of mineral wool tightly packed into aperture between substrate and the surface of the steel duct

*To BS476: Part 24 only



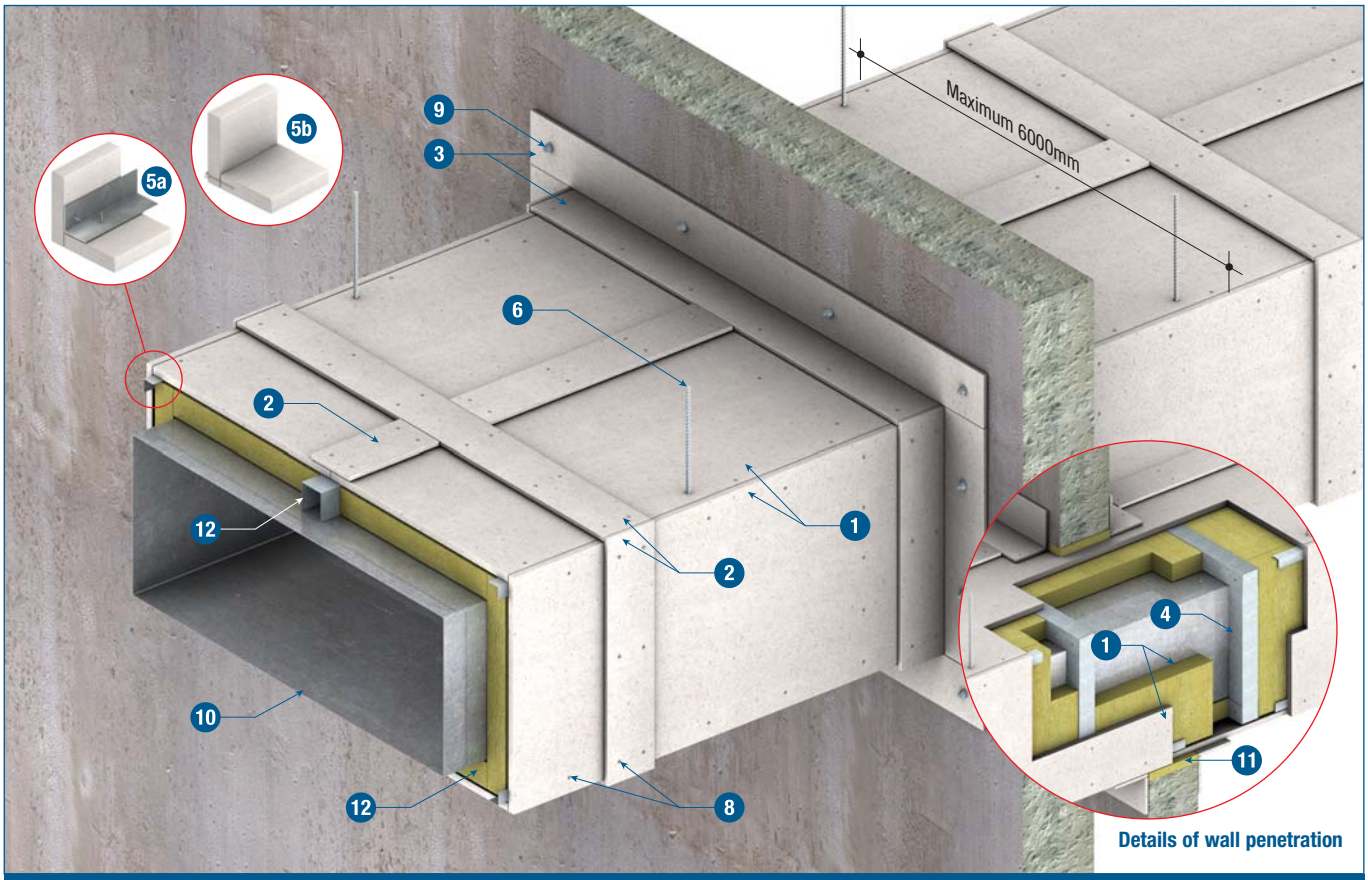
Details of steel channels around duct

Fire resistant ducts can be formed where the substrate from which the steel duct is supported provides protection to some areas, thus 1, 2 and 3-sided solutions in combination with walls and ceilings are available. See page 10.

The above construction of fire resistant encasements around steel ducts is up to 1500mm wide in accordance with the criteria of BS476: Part 24 and AS1530: Part 4, exposed to external and internal fire. However, PROMATECT®-H duct systems are approved for up to 10m wide. Variations on supporting components for duct width up to 15m are available on request.

As an alternative fixing method, the angle at the corner and the channel at the butt joints can be replaced by PROMATECT®-H cover strips 25mm x 25mm and 25mm x 50mm respectively. The installation time will then be shortened by using steel staples at nominal 100mm centres instead of screws.

For impact resistant systems in accordance with the criteria BS5669: Part 1 exposed to external and internal fire, 15mm, 20mm or 25mm thick PROMATECT®-H boards are required. Insulation will be as Duct type B (exposed to internal fire).



Details of wall penetration

TECHNICAL DATA

1 1 layer of PROMATECT®-H board, see page 2 for details.

For FRL of 120/120/-	9mm thick
For FRL of 120/120/30*	15mm thick
For FRL of 120/120/120*	15mm thick with 1 layer of mineral wool 50mm x 100kg/m³
For FRL of 240/240/-	12mm thick
For FRL of 240/240/120*	15mm thick with 1 layer of mineral wool 80mm x 100kg/m³
For FRL of 240/240/240*	25mm thick with 2 layers of mineral wool 50mm x 100kg/m³ each

2 1 layer of PROMATECT®-H cover strips, 100mm wide x board thickness according to the desired FRL.

3 1 layer of PROMATECT®-H collars, 150mm wide x board thickness according to the desired FRL, fitted around the duct on both sides on the wall forming an L-shape.

4 For duct span up to 3000mm
Steel channels 50mm x 50mm x 0.9mm thick around duct, spaced at centres in accordance to the width of the duct to ensure a maximum unsupported area not exceeding 1.5m².

5a Steel angles 30mm x 30mm x 0.6mm thick or

5b Screw boards face to edge using deep threaded screws with a minimum 25mm penetration (for boards 20mm or greater thickness)

6 Duct hanger system, stress calculation according to page 5.

7 Steel angles minimum 30mm x 30mm x 3mm thick according to duct weight and size and maximum permitted stress levels

8 No.8 self-tapping screws at nominal 200mm centres or steel wire staples 28/10/1mm at nominal 100mm centres

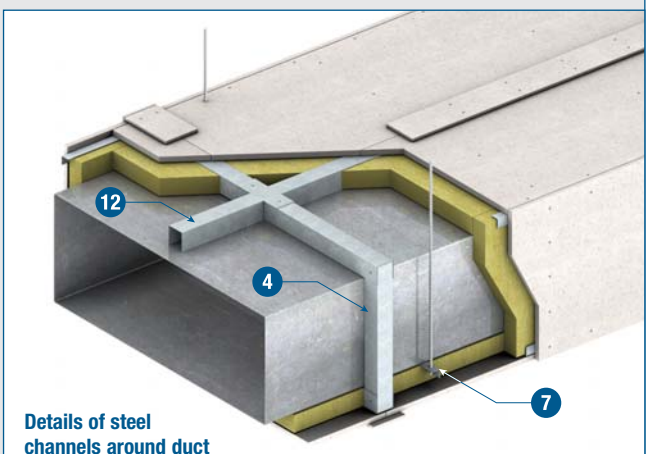
9 M6 anchor bolts at nominal 600mm centres

10 Mild steel ventilation duct

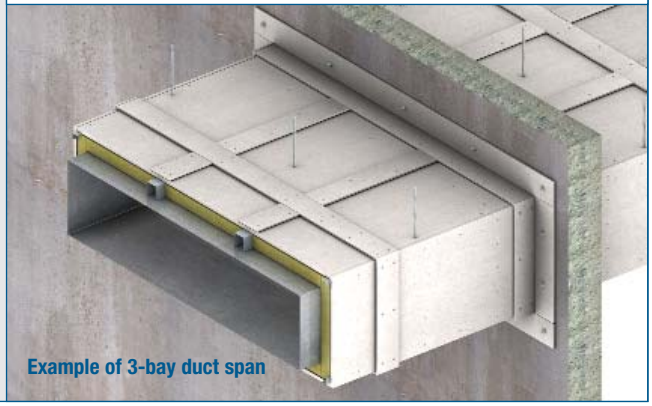
11 1 layer of mineral wool tightly packed into aperture between substrate and the surface of the steel duct

12 For duct span between 3000mm to maximum 6000mm
Additional support brackets at mid span, please consult Promat Technical Department for construction details.

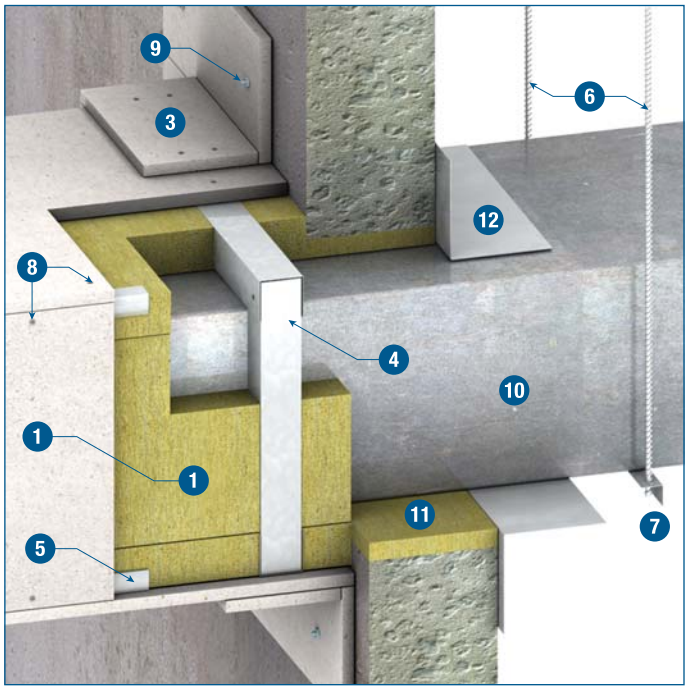
*To BS476: Part 24 only



Details of steel channels around duct



Example of 3-bay duct span



Wall penetration at termination of fire resisting section of a duct system

There are multiple options available when joining galvanised steel ducts to Promat duct sections. These include the use of flexible connections, especially when connecting the duct system to vibrating elements of machinery, e.g. fans. The flexible material should be held in place with flat bar steel strips of not less than 2mm thick attached with suitable fixings. Where a proprietary brand of lightweight material is used, consideration should be given to the size of connection and how it is fitted. The more heavy weight type of flexible material may also be obtained, formed into a channel section with corners fitted and stitched to give a neat airtight joint. Please consult Promat technical department for details of the approved systems.

Sometimes it is necessary to connect a Promat duct to a circular steel duct section or a circular fan connector. To do so, the rectangular cross-section of the Promat duct must be fabricated larger than the diameter of the circular section to be connected. The end of rectangular PROMATECT®-H duct is then blanked off with a section of Promat board with a circular hole the diameter of the circular duct or section to be joined.

If there is a requirement for services to be installed with the ductwork enclosure, care must be taken to ensure that the installed services do not compromise the fire integrity or insulation property of the PROMATECT®-H ductwork. This can be achieved by using non-combustible material, and where the services penetrate the ductwork, appropriate fire-stopping measures are taken combustible plastics pipes and high-risk power cables should not be installed within the ductwork enclosures.

At wall penetrations, the gaps between the duct and the reveals of the opening must be filled with mineral wool, of minimum density 100kg/m^3 and an L-shaped collar formed from the Promat board around the duct on both sides of the wall. The minimum size of the collar is 150mm x 150mm and it is screwed and bonded to the duct, but is not fixed to the wall.

Minimum dimension of collars at penetrations seals will vary and is determined by fire resistance level and duct size. In general, collars should be constructed from boards of the same type and thickness as used for the duct. The minimum width of the collar can vary between 80mm to 150mm. Please consult Promat for details. Alternatively use a minimum width of 150mm horizontal and vertical collar.

TECHNICAL DATA

1. 1 layer of PROMATECT®-H board, see page 2 for details.
   - For FRL of 120/120/- : 9mm thick
   - For FRL of 120/120/30* : 15mm thick
   - For FRL of 120/120/120* : 15mm thick with 1 layer of mineral wool 50mm x 100kg/m^3
   - For FRL of 240/240/- : 12mm thick
   - For FRL of 240/240/120* : 15mm thick with 1 layer of mineral wool 80mm x 100kg/m^3
   - For FRL of 240/240/240* : 25mm thick with 2 layers each of mineral wool 50mm x 100kg/m^3
2. 1 layer of PROMATECT®-H cover strips, 100mm wide x board thickness according to the desired FRL.
3. 1 layer of PROMATECT®-H collars, 150mm wide x board thickness according to the desired FRL, fitted around the duct on both sides on the wall forming an L-shape.
4. For duct span up to 3000mm
   Steel channels 50mm x 50mm x 0.9mm thick around duct, spaced at centres in accordance to the width of the duct to ensure a maximum unsupported area not exceeding 1.5m^2.
5. Steel angles 30mm x 30mm x 0.6mm thick
6. Duct hanger system,
   stress calculation according to page 5.
7. Steel angles minimum 30mm x 30mm x 3mm thick according to duct weight and size and maximum permitted stress levels
8. No.8 self-tapping screws at nominal 200mm centres
9. M6 anchor bolts at nominal 600mm centres
10. Mild steel ventilation duct
11. 1 layer of mineral wool tightly packed into aperture between substrate and the surface of the steel duct
12. Existing steel duct flange
13. Ventilation control device (VCD)
14. M6 anchor bolts, nuts and washer at nominal 250mm centres

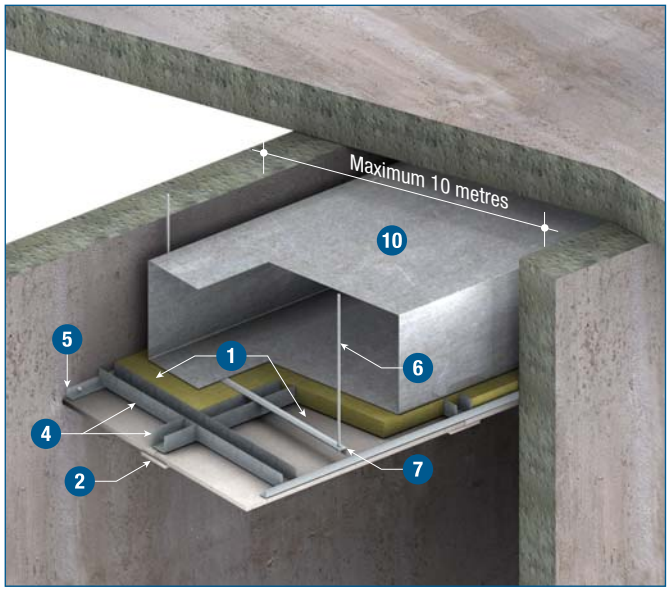
*To BS476: Part 24 only

Fire resistant ducts can be formed where the substrate from which the steel duct is supported provides protection to some areas, thus 1, 2 and 3-sided solutions in combination with walls and ceilings are available. See opposite page.

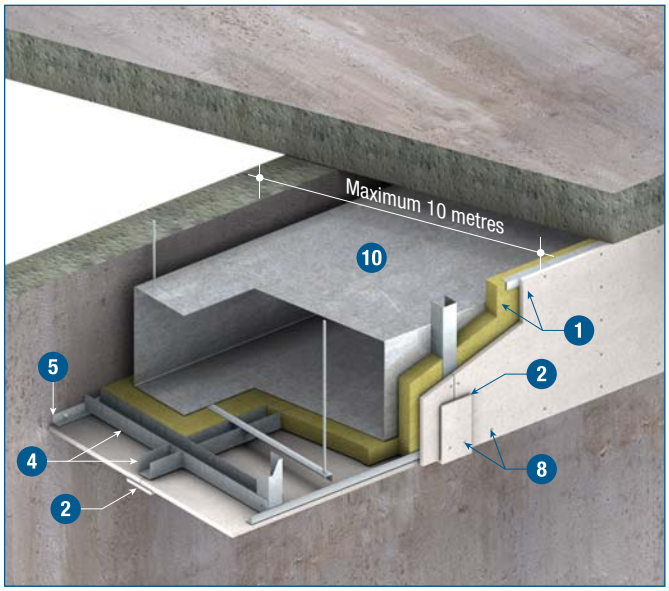
The construction of fire resistant encasements around steel ducts is up to 1500mm wide in accordance with the criteria of BS476: Part 24 and AS1530: Part 4, exposed to external and internal fire. However, PROMATECT®-H duct systems are approved for up to 10m wide. Variations on supporting components for duct width up to 15m are available on request.

For impact resistant systems in accordance with the criteria BS5669: Part 1 exposed to external and internal fire, 15mm, 20mm or 25mm thick PROMATECT®-H boards are required. Insulation will be as Duct type B (exposed to internal fire).

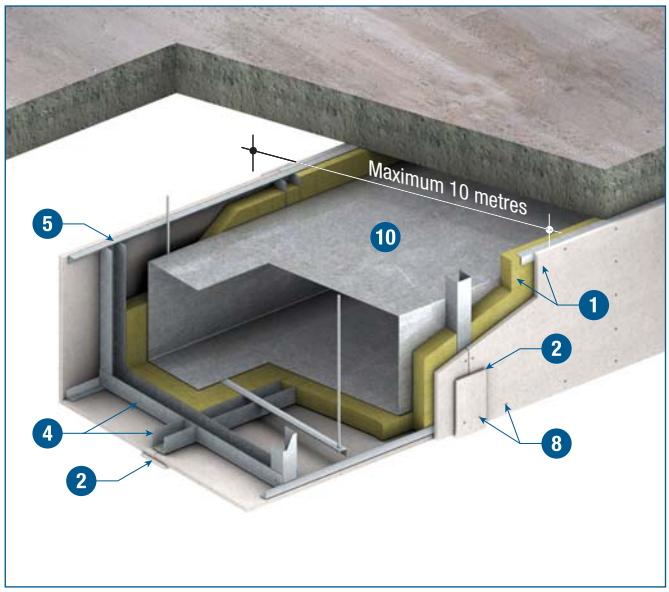
Example of 1-sided duct cladding



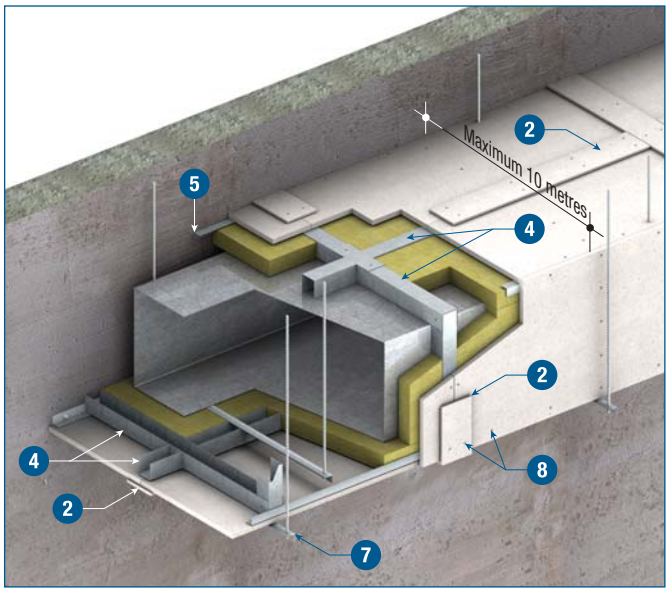
Example of 2-sided duct cladding



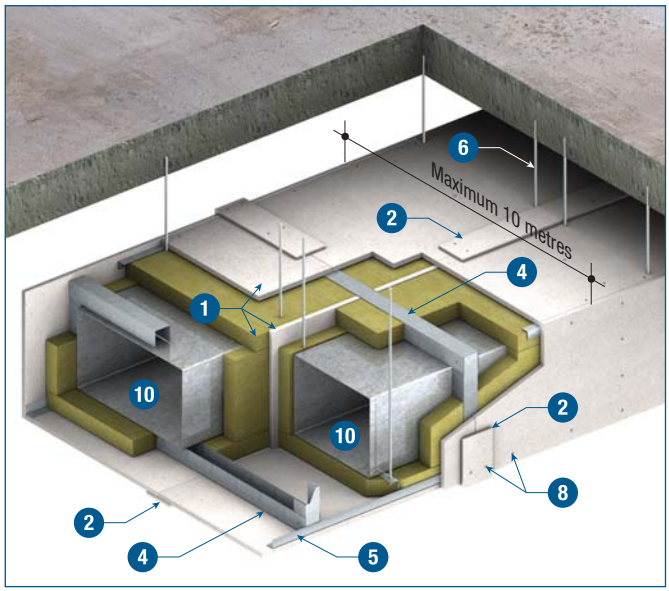
Example of 3-sided duct cladding (from the underside of the substrate)



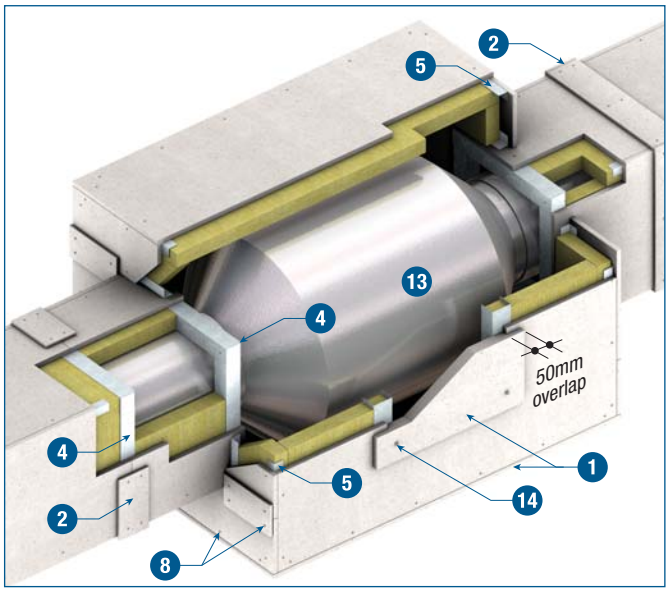
Example of 3-sided duct cladding (to the side of the substrate)



Example of cladding multiple ducts



Example of cladding protection for VCD, silencers etc



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