MULTIPLEX

CONSTRUCTION HANDBOOK - SERVICES

Version 01

Print Copy

Disclaimer

This is a print version whereas the structure of the construction handbook may have been adapted for ease of reference.

The handbook app should take precedence in case of any ambiguity.

Multiplex Constructions Pty Limited

multiplex.global

CONTENTS

1. Services

1.1 Mechanical

1.1.1 Rigid Duct

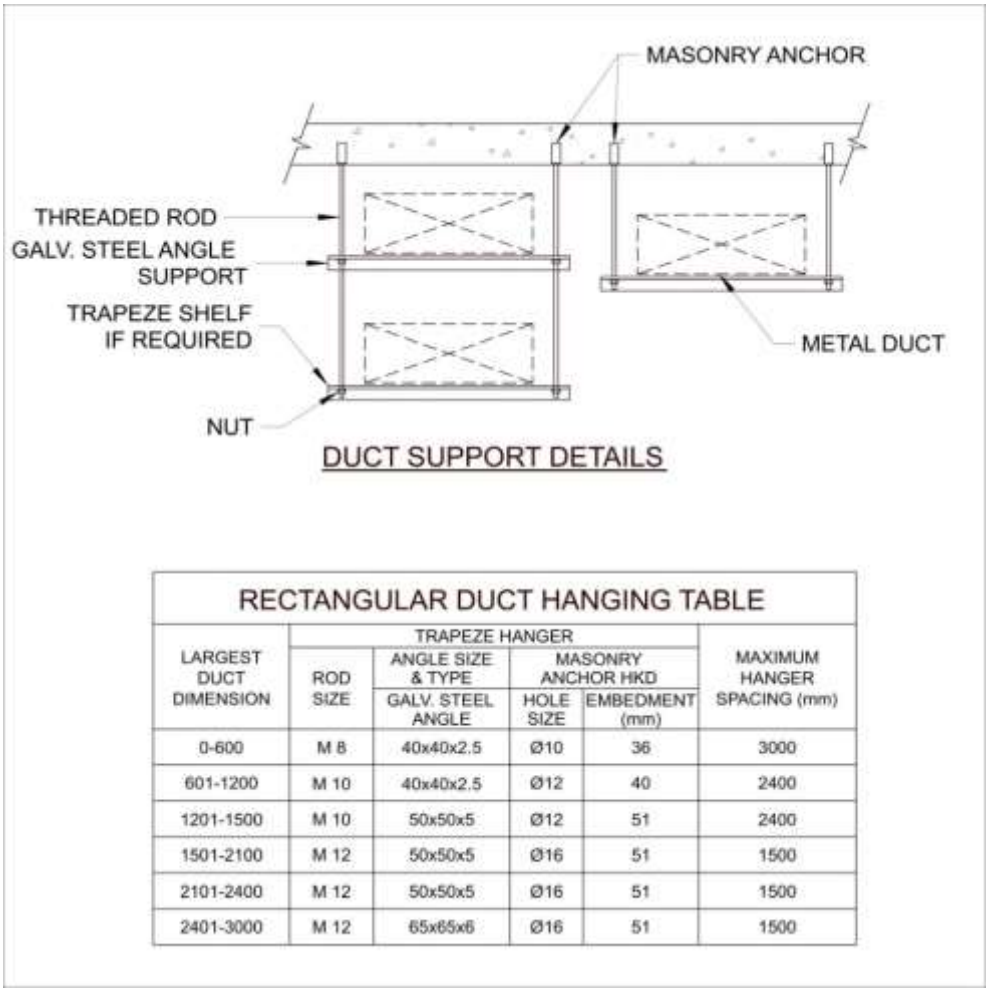
General

All duct construction details must be approved by the Mechanical Consultant.

Supports

Straps and rods

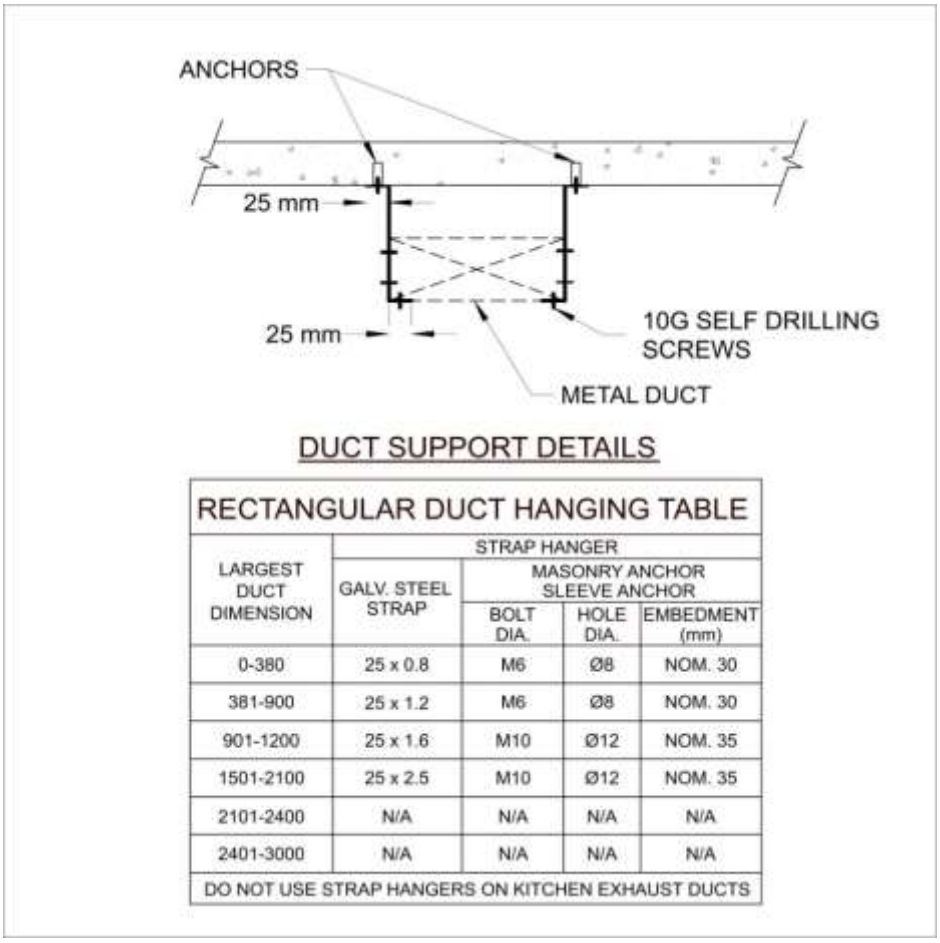
- Strap and rod hanging and support systems in accordance with *Clause 2.6.1 of AS4254.2* for rectangular and round duct, air terminals and air-handling plant must be:
    - Installed as per approved ductwork installation and manufacturer details submitted by the subcontractor (refer examples below).
    - Bolted or screwed or attached to the supporting structure in such a manner as to maintain the load-carrying capacity of the hanger.
- Straps must be fixed to the underside of the duct.



RECTANGULAR DUCT HANGING TABLE

LARGEST DUCT DIMENSION	TRAPEZE HANGER				MAXIMUM HANGER SPACING (mm)
	ROD SIZE	ANGLE SIZE & TYPE	MASONRY ANCHOR HKD		
		GALV. STEEL ANGLE	HOLE SIZE	EMBEDMENT (mm)	
0-600	M 8	40x40x2.5	Ø10	36	3000
601-1200	M 10	40x40x2.5	Ø12	40	2400
1201-1500	M 10	50x50x5	Ø12	51	2400
1501-2100	M 12	50x50x5	Ø16	51	1500
2101-2400	M 12	50x50x5	Ø16	51	1500
2401-3000	M 12	65x65x6	Ø16	51	1500

Figure 1: Rectangular Duct Minimum Hanger Hangers – Indicative Only (MPX)



DUCT SUPPORT DETAILS

RECTANGULAR DUCT HANGING TABLE

LARGEST DUCT DIMENSION	STRAP HANGER			
	GALV. STEEL STRAP	MASONRY ANCHOR SLEEVE ANCHOR		
		BOLT DIA.	HOLE DIA.	EMBEDMENT (mm)
0-380	25 x 0.8	M6	Ø8	NOM. 30
381-900	25 x 1.2	M6	Ø8	NOM. 30
901-1200	25 x 1.6	M10	Ø12	NOM. 35
1501-2100	25 x 2.5	M10	Ø12	NOM. 35
2101-2400	N/A	N/A	N/A	N/A
2401-3000	N/A	N/A	N/A	N/A
DO NOT USE STRAP HANGERS ON KITCHEN EXHAUST DUCTS				

Figure 2: Rectangular Duct Minimum Strap Hangers – Indicative Only (MPX)

TABLE 2.(C)

ROUND DUCT HANGERS - MINIMUM SIZE

Duct dia.	Maximum spacing	Rod dia.	Strap size	One rod system dia.	Horizontal tie rod with one rod system dia.
Up to 250	3600	6	25 x 0.8	-	-
251 to 450	3600	6	25 x 0.8	-	-
451 to 600	3600	6	25 x 0.8	-	-
601 to 900	3600	2 x 8	25 x 0.8	10	10
901 to 1250	3600	2 x 10	2 x 25 x 1.0	12 + F/B	12
1251 to 1500	3600	2 x 10	2 x 25 x 1.2	12 + F/B	12
1501 to 2100	3600	2 x 10	2 x 25 x 1.6	15 + F/B	15

Figure 3: Round Duct Hangers Minimum Sizes - Reproduced from AS 4254.2, excluding errata

Wire rope suspension systems

Wire rope suspension hangers and supports in accordance with *Clause 2.6.2 of AS4254.2* for rectangular and round duct, air terminals and air-handling plant must be:

- Installed in accordance with manufacturers' specifications
- Must be supplied as a matched and load-tested system
- Comprise multi-strand wire rope of galvanized or stainless-steel material
- Include an integrated end-fixing that provides attachment to the building fabric, duct, or suspension lugs provided on an air terminal or air-handling plant.
- Manufacturer and safe working load, in kilograms (kg) shall be legibly and permanently marked on each suspension system locking device.
- Where 'essential services' or 'fire-rated duct', as defined in the NCC, are required by the NCC to be fire-rated, the wire rope suspension system shall have the same fire rating as the suspended 'essential services' or 'fire-rated duct'.
- Fixed to the structure, substructure (e.g. Unistrut) or a catenary, not other services.
- Hung vertically unless part of a seismic restraint system.

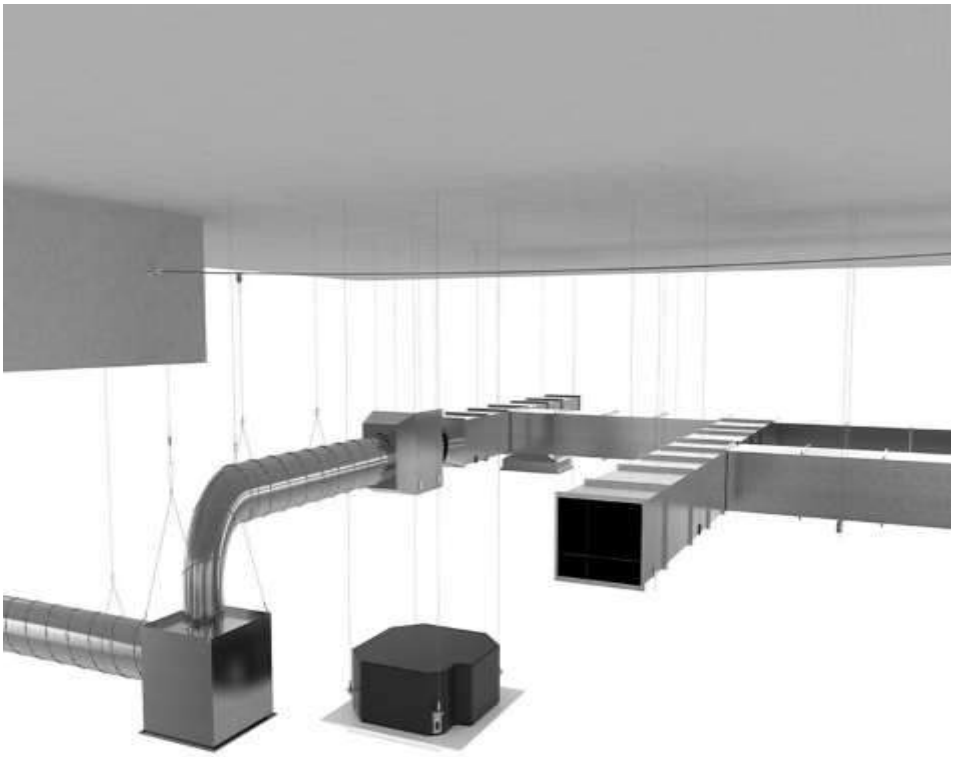


Figure 4: Typical examples of wire rope arrangements, Gripple

Figure 5: Integrated end-fixings, 45 degree eyelet, Gripple

Figure 6: Integrated end-fixings,90 degree eyelet, Gripple

Figure 7: Integrated end-fixings, Ceiling anchor, Gripple

Figure 8: Integrated end-fixings, Ceiling anchor, Gripple

Figure 9: Integrated end-fixings, Eyelet, Gripple

Figure 10: Integrated end-fixings, Karabiner, Gripple

Ductwork Joints

Ductwork joints must:

- Be installed as per approved ductwork installation and manufacturer details submitted by the subcontractor
- Have the required slides, angles and number of cleats/clips (where used) installed as per diagram below
- Be inspected by Multiplex prior to insulation and risers being closed.

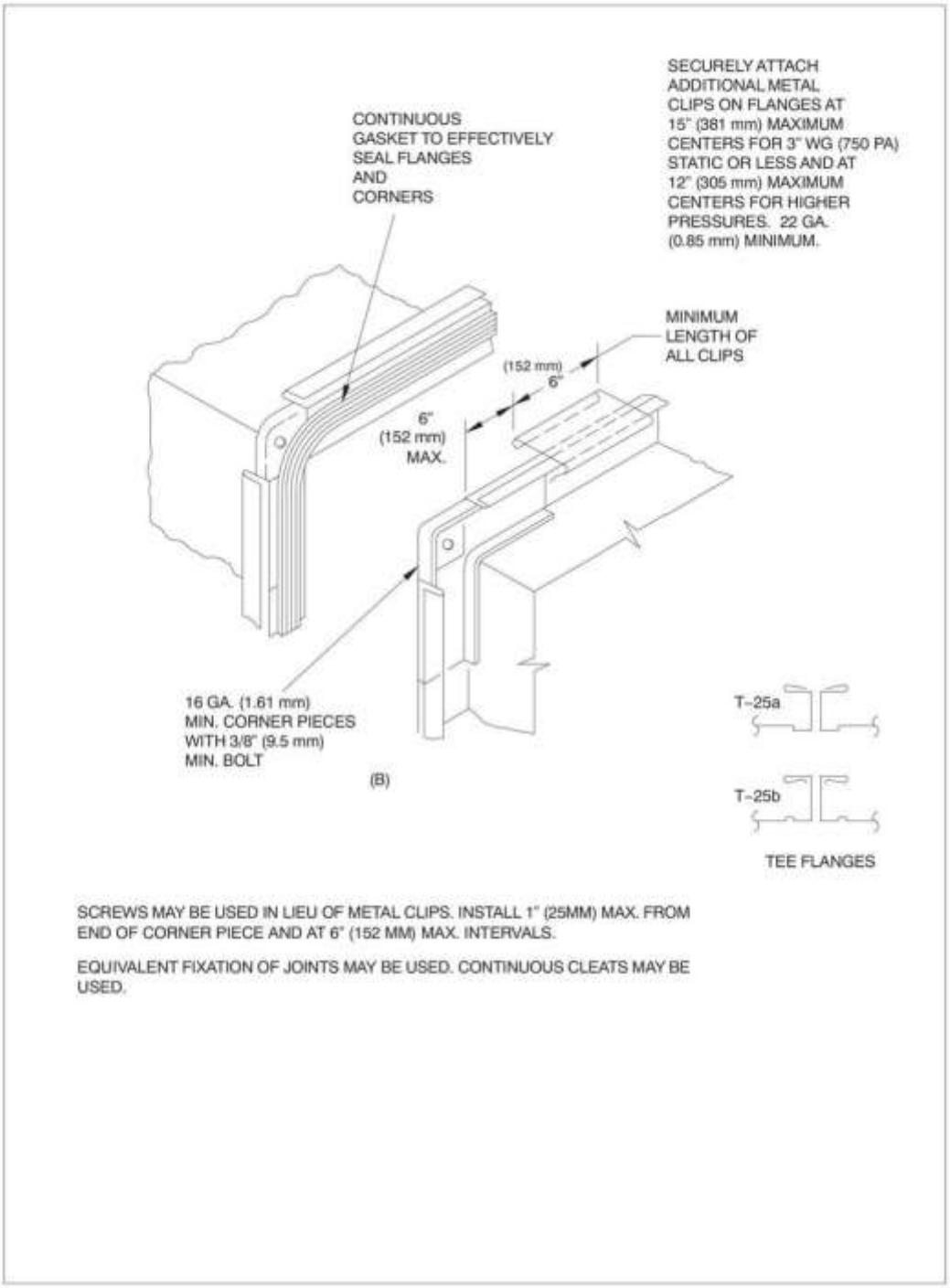


FIGURE 2-17 CORNER CLOSURES – FLANGES

Figure 11: SMACNA Duct construction details

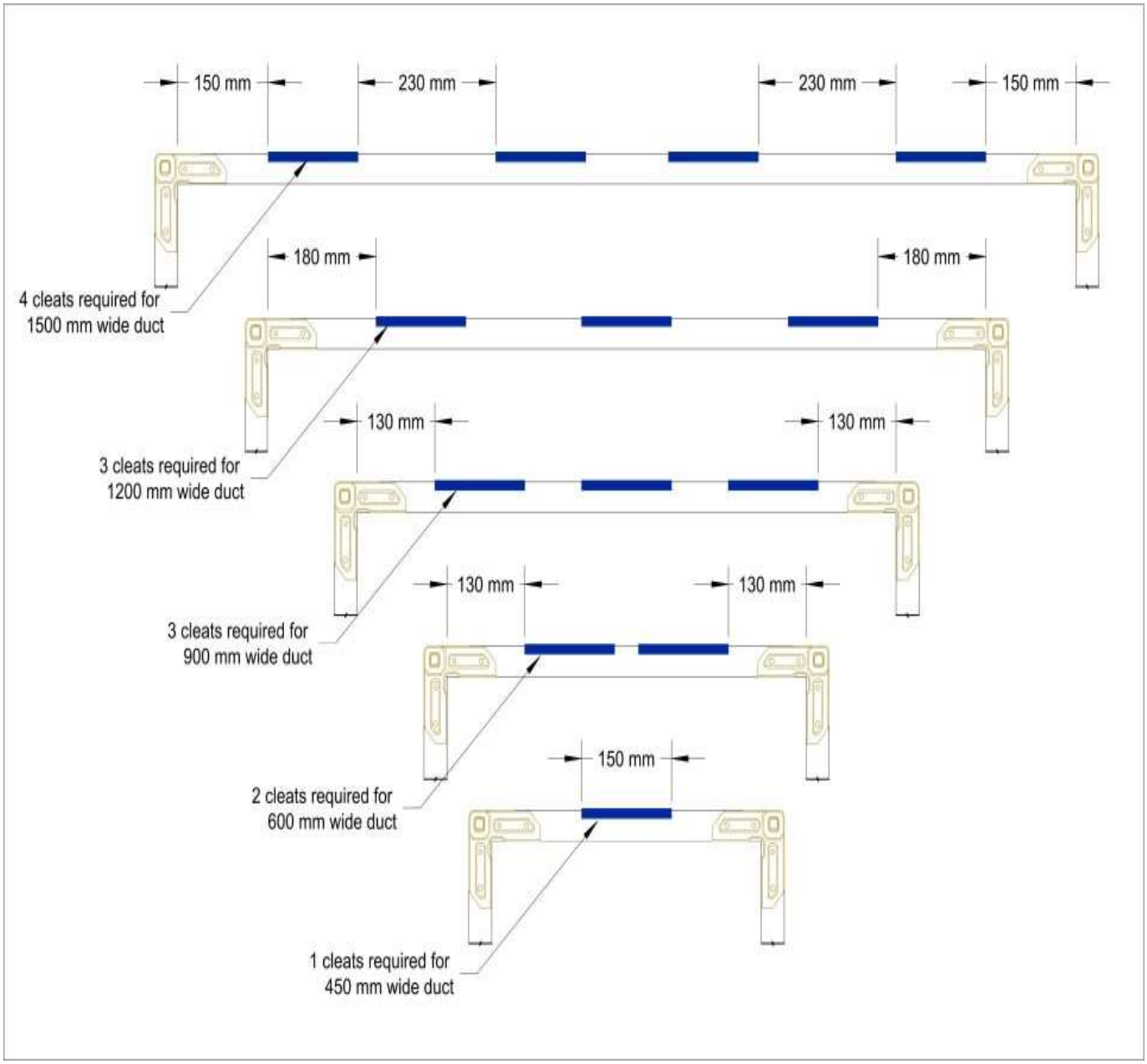


Figure 12: Recommended T.D.C./T.D.F Clip spacing, DMT

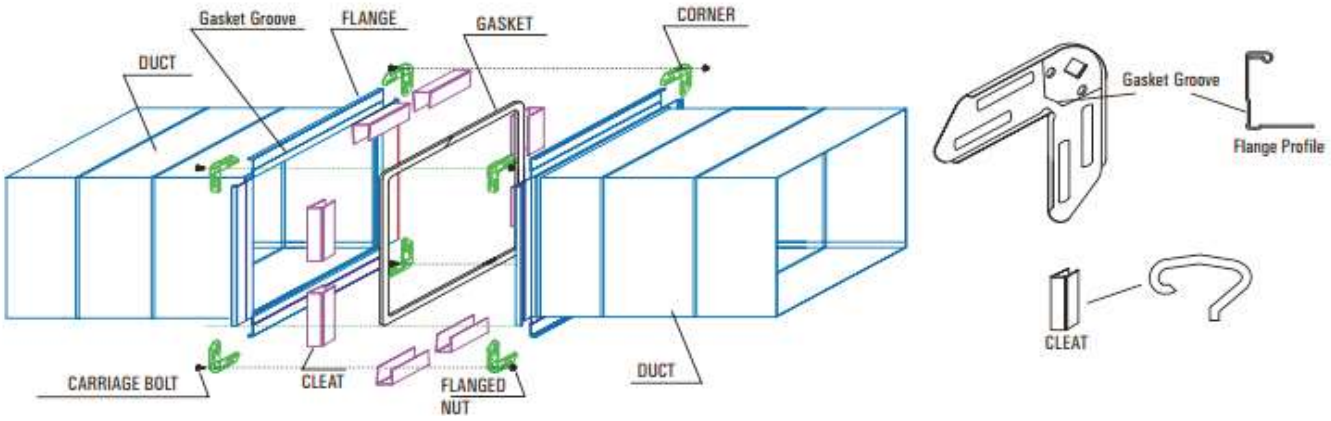


Figure 13: Components of a T.D.C. connection, Google Images

Ductwork Connection Sealing

Joints and seams of ductwork must be:

- Sealed, and
- Inspected by Multiplex prior to insulation being installed.

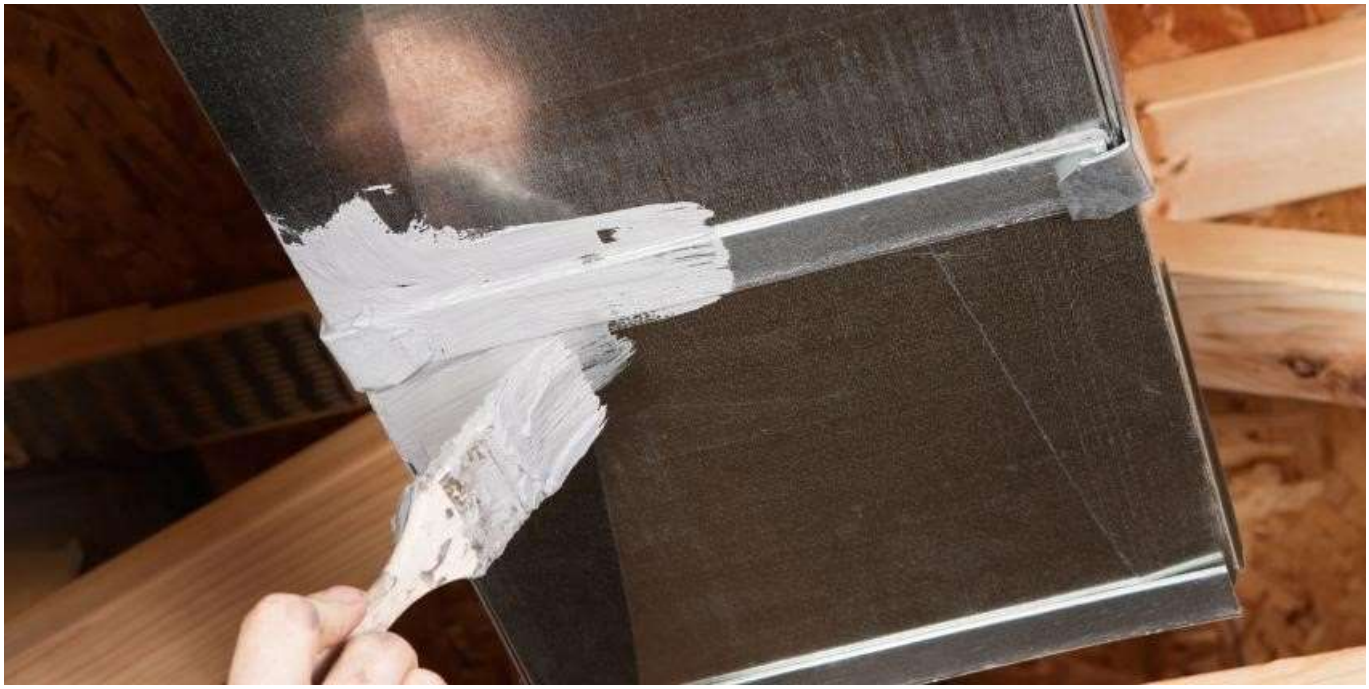
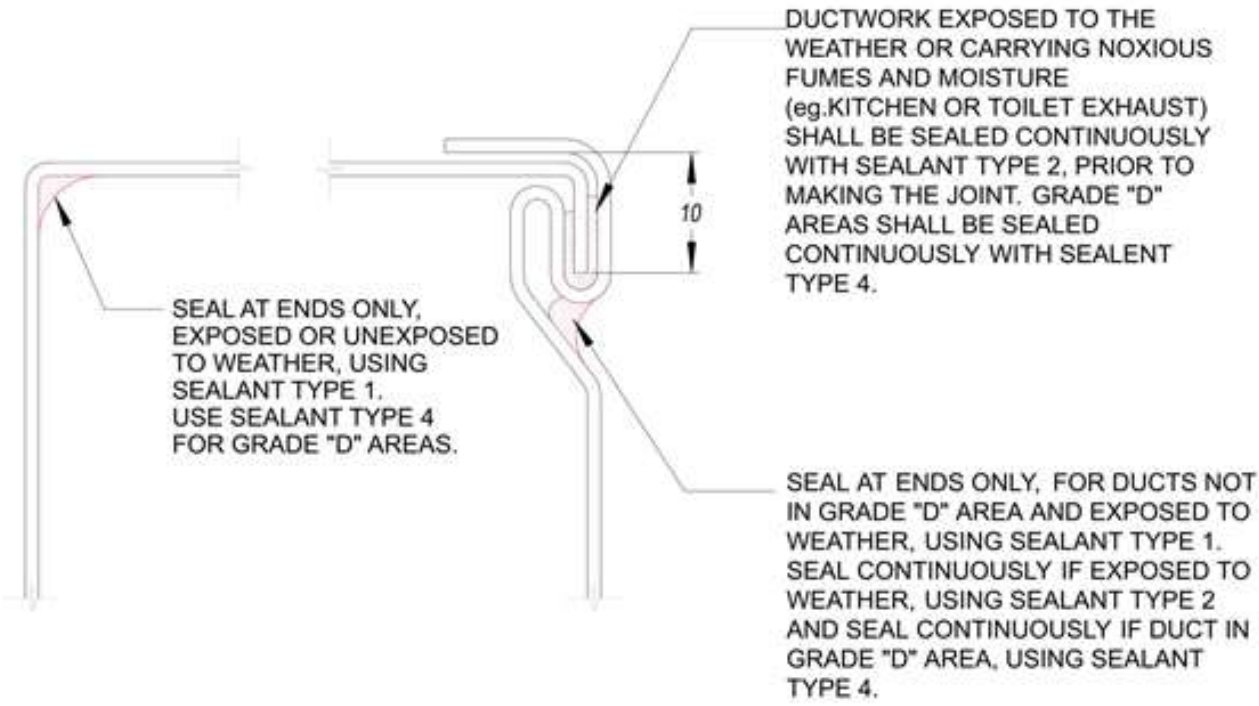


Figure 14: Sealing of duct joint corners and slide joints, source https://www.allbritten.com/air-duct-sealing

Figure 15: White mastic on all joints, Conklin Metal Industries



TYPES OF SEALANTS	
GENERAL DUCT SYSTEMS	
TYPE	
1	FOSTERS DUCT SEALANT - 32-19
2	DUCT SEALER 1465 - BY BOSTIK
3	BOOV - BY 3M
4	SEAL 'N' FIX PU - BY BOSTIK (GRADE 'D' PHARMACEUTICAL APPLICATIONS ONLY)
5	HILASTIC 88 - BY EXPANDITE

Figure 16: Longitudinal joint seals, example, MPX

Duct Insulation

- External duct insulation must be installed:
  - After the hanging system is attached and inspected by Multiplex
  - With hangers, straps or fasteners that do not to compress the insulation
  - In accordance with the manufacturer's instructions
  - With vapour seals (where required) that are continuous and any tears patched/taped up
  - With an approved method which may include:
    - Straps, or
    - Mechanical fasteners (fixing pins)
    - At 75mm from transverse joints and at:
    - For horizontal ducts above 600 mm hold the insulation in position on the underside by means of fixing pins spaced at 400 mm maximum centres with a minimum, of one row.
    - For vertical duct above 600 mm and above provide pins to all sides at maximum of 400 mm centres[1].

[1] *Copied from TICA Qld Standard Specification Thermal and Acoustic Insulation.*

Figure 17: Ductwork insulation with mechanical fasteners (fixing pins)

Figure 18: Ductwork insulation after hanging system is installed

Duct Beading, Stiffening and Reinforcement

Rectangular ducts in accordance with *Clause 2.3 of AS 4254.2* must be constructed in accordance with the approved ductwork installation and manufacturer details submitted by the subcontractor (refer examples below).

RECTANGULAR DUCTWORK CONSTRUCTION TABLES

0 TO 250Pa DUCT PRESSURE

METRIC DIMENSION(mm)	GAUGE	END JOINTS	MAX CENTRES FOR END JOINTS	INTERMEDIATE STIFFENERS	INT. STIFFENER CENTRES	BEADING
0 - 250	0.6	DC	2400	NIL	N.A.	NO
251 - 1200	0.6	TDC	1500	NIL	N.A.	YES
1201 - 1500	0.8	TDC	1500	NIL	N.A.	YES
1501 - 1800	1.0	TDC	1500	40x40x3 DURAGAL	750	YES
1801 - 2100	1.0	TDC + 1TIE ROD	1500	40x40x5 DuRAGAL	750	YES
2101 - 2400	1.0	TDC + 1TIE ROD	1500	40x40x5 DURAGAL	750	YES
2400+	1.2	TDC + 1TIE ROD	1500	50x50x5 DURAGAL	750	YES

0 TO 500Pa DUCT PRESSURE

METRIC DIMENSION(mm)	GAUGE	END JOINTS	MAX CENTRES FOR END JOINTS	INTERMEDIATE STIFFENERS	INT. STIFFENER CENTRES
0 - 250	0.6	DC	2400	NIL	N.A.
251 - 750	0.6	TDC	1500	NIL	N.A.
751 - 1200	0.8	TDC	1500	NIL	N.A.
1201 - 1350	1.0	TDC	1500	NIL	750
1351 - 1500	1.0	TDC	1500	40x40x3 DURAGAL	750
1501 - 1800	0.8	TDC + 1TIE ROD	1500	40x40x5 DURAGAL	750
1801 - 2100	1.0	TDC + 1TIE ROD	1500	40x40x5 DURAGAL	750
2101 - 2400	1.0	TDC + 1TIE ROD	1500	50x50x5 DURAGAL	750
2400+	1.2	TDC + 1TIE ROD	1500	40x40x5 DURAGAL+TIE ROD	750

0 TO 750Pa DUCT PRESSURE

METRIC DIMENSION(mm)	GAUGE	END JOINTS	MAX CENTRES FOR END JOINTS	INTERMEDIATE STIFFENERS	INT. STIFFENER CENTRES
0 - 250	0.6	TDC	1500	NIL	N.A.
251 - 750	0.6	TDC	1500	NIL	N.A.
751 - 1200	1.0	TDC	1500	NIL	N.A.
1051 - 1200	0.8	TDC	1500	40x40x2.5 DURAGAL	N.A.
1201 - 1350	0.8	TDC	1500	40x40x2.5 DURAGAL	750
1351 - 1500	1.0	TDC	1500	40x40x3 DURAGAL	750
1501 - 1800	0.8	TDC + 1TIE ROD	1500	40x40x5 DURAGAL	750
1801 - 2100	1.0	TDC + 1TIE ROD	1500	40x40x5 DURAGAL	750
2101 - 2400	1.2	TDC + 1TIE ROD	1500	50x50x6 DURAGAL	750
2400+	1.2	TDC + 1TIE ROD	1500	40x40x5 DURAGAL+TIE ROD	750

Figure 19: Rectangular duct construction tables, example, MPX

General Installation

- Other services are not to be supported on ductwork supports unless approved by the mechanical subcontractor.
- Ductwork must be:
    - Installed without touching other ducts, pipes, trays or hangers or any other infrastructure.
-
    - Neatly set out, level and parallel with walls/other services.

Figure 20: Ductwork in contact with other duct

Temporary Protection

All ductwork must have:

- Protection with end covers when brought to site
- End covers in place until the next section of duct is attached
- End covers removed when the next section of duct is attached
- Internal duct labels removed.

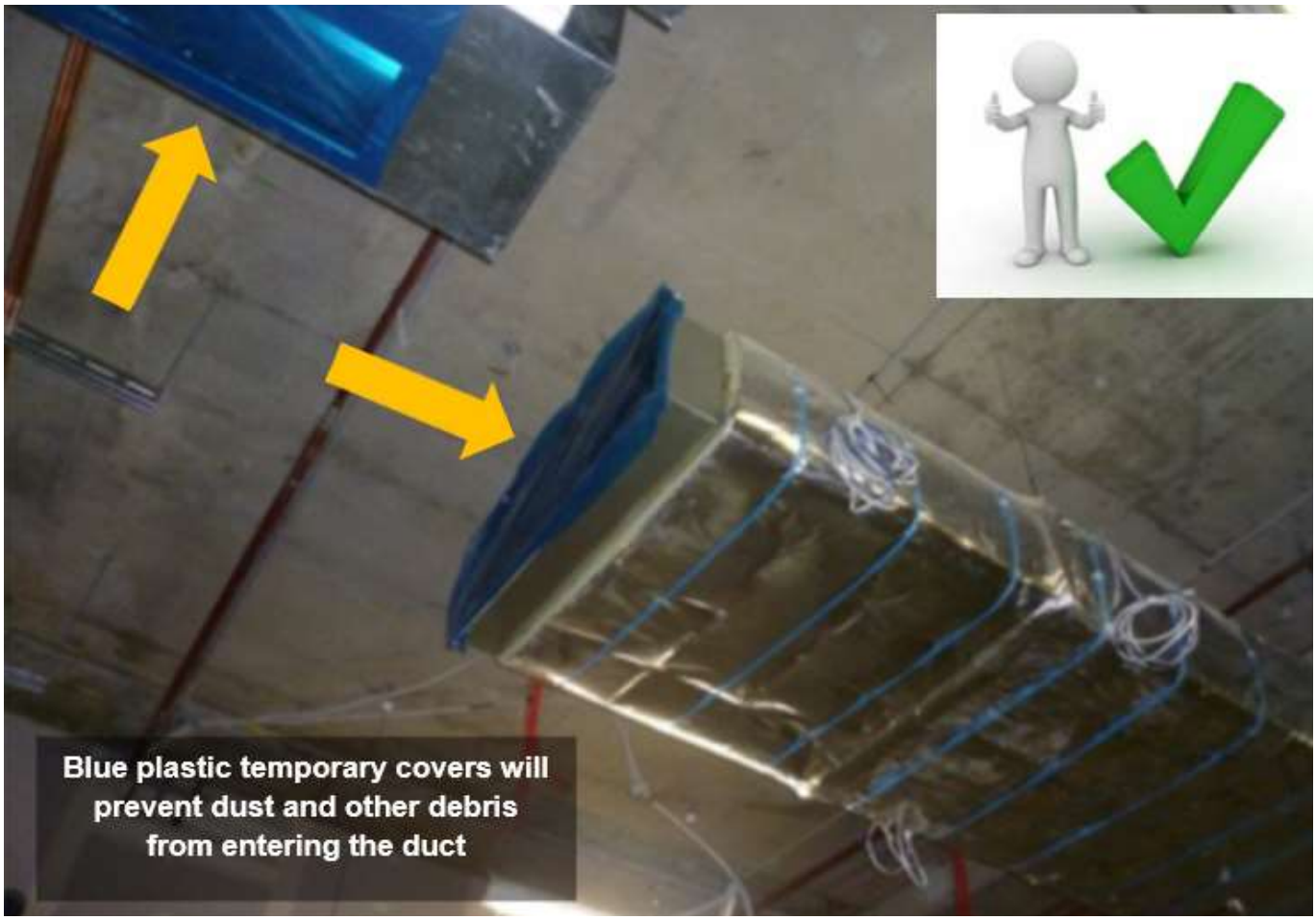


Figure 21: Duct End Covers

1.1.2 Flexible Duct

Supports

- Flexible duct hangers or saddles in contact with the flexible duct in accordance with *Clause 2.5.3 of AS4254.*1 must:
    - Be a minimum width of 25mm.
    - Have semi-rigid, fire resistant, load distributing support material with a minimum width of 75mm for at least a quarter of its circumference.
- Flexible duct support must be spaced in accordance with *Clause 2.5.3 of AS4254.1:*
- No greater than 1500mm apart
- With no greater than 40mm/m of sag per support.

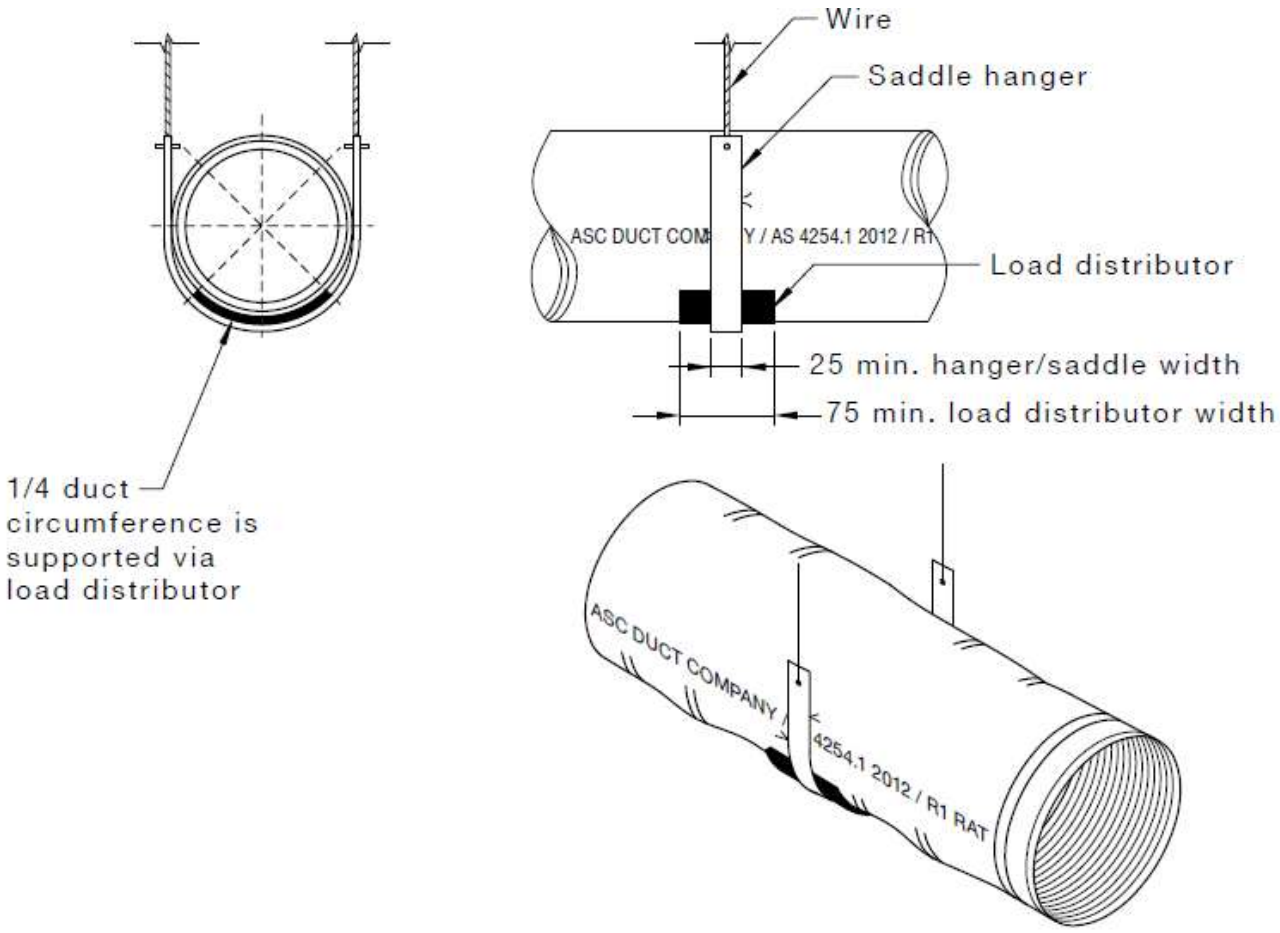


Figure 22: AS4254.1 hanging saddle and load distribution support systems figure 2.5.2(c)

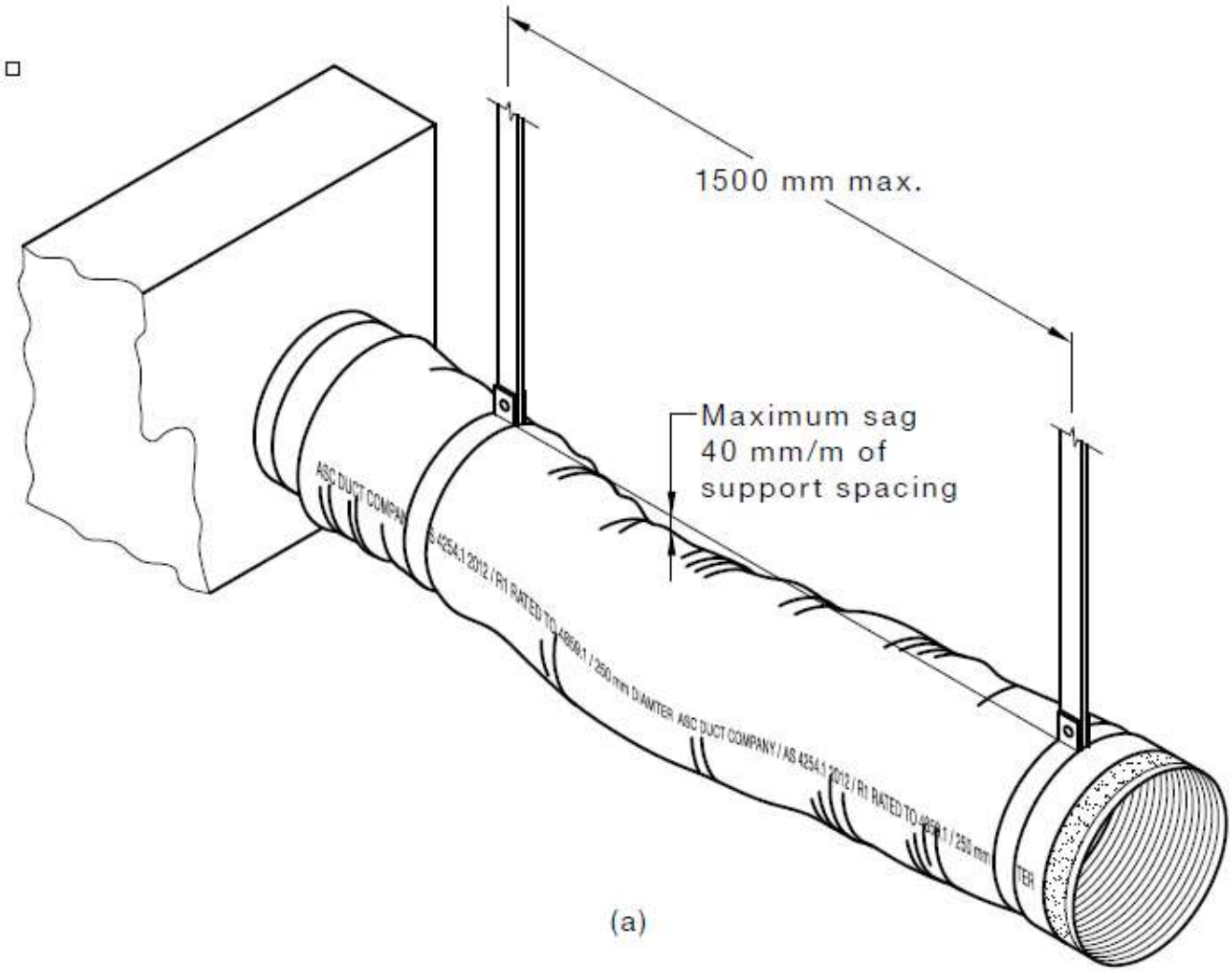


Figure 23: Figure 2.5.2(A) of AS4254. Flexible Duct Installation—Hanging

Connections

- Flexible duct must be:
  - Cut to length when less than a full length is required, N.B. excess removed.
  - A single length of 6 m maximum. No intermediate joins are permitted. (Classes 4 to 9)
  - Not more than two lengths of up to 6m (Classes 1 to 3)
  - Attached to spigots preferably of min 150 mm in length.
- Where duct tape is used as a sealing media, it must be:
  - Minimum 0.15 mm thick and 48 mm wide
  - Minimum of three overlapping wraps adhered to a collar on an air terminal device as outlined below.
- Where mechanical fixing is used, it must be fastened permanently to circular collars on air terminal devices by means of a drawband/banding system located over the top of the air seal.
- Vapour seals (where required) are to be continuous and any tears patched/taped up

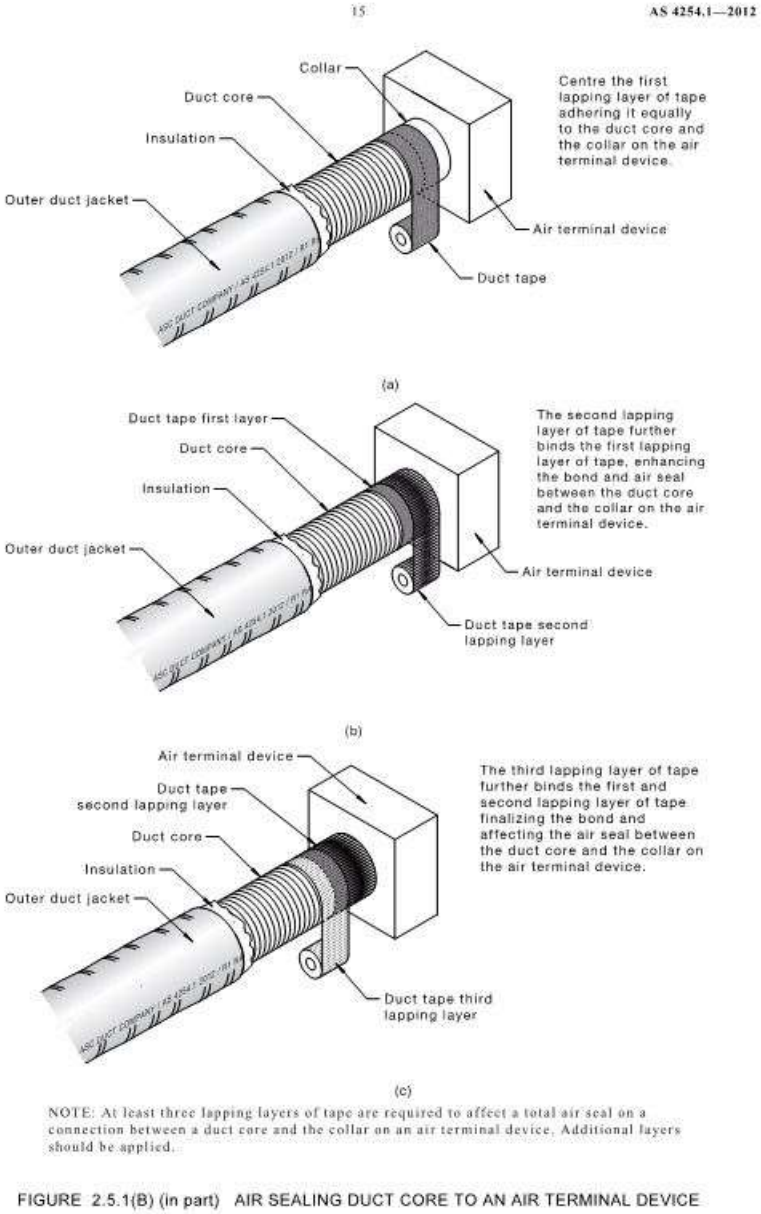
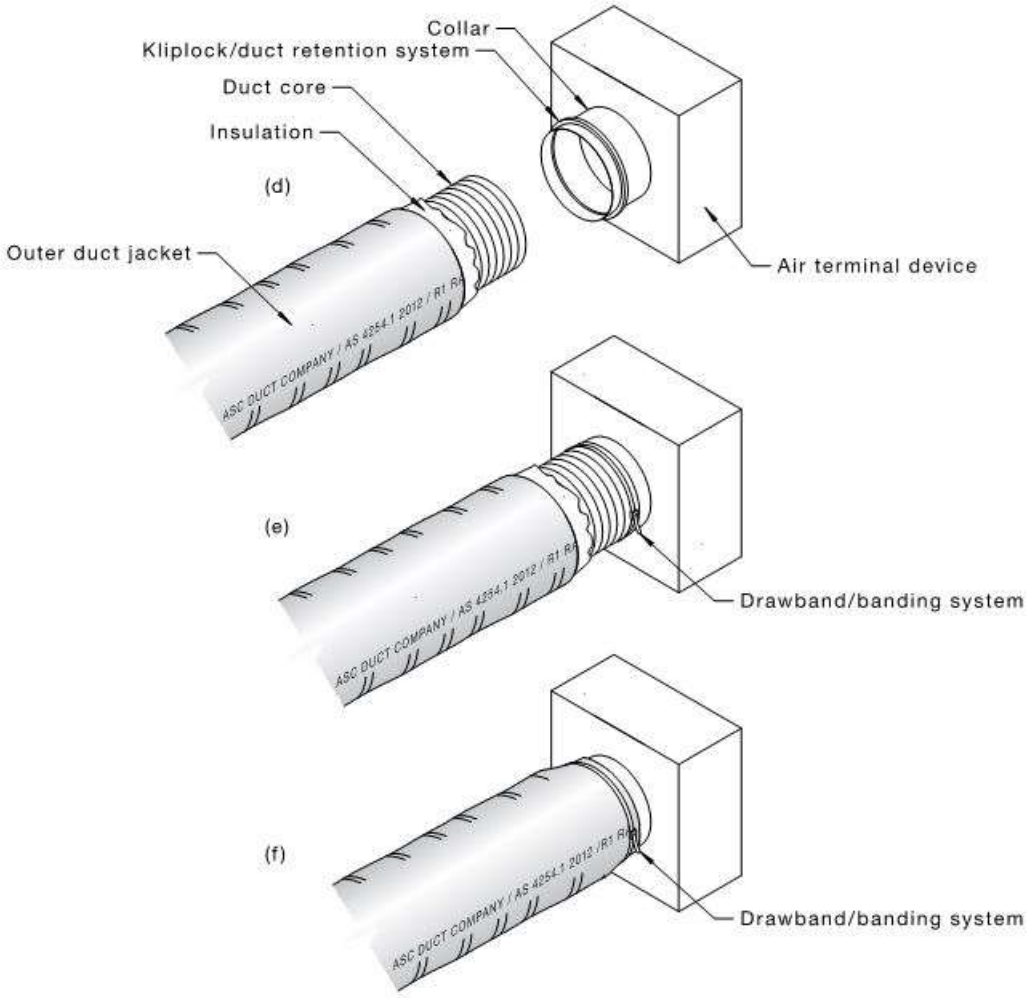


FIGURE 2.5.1(B) (in part) AIR SEALING DUCT CORE TO AN AIR TERMINAL DEVICE

Figure 24: An extract from AS 4254.1



FIGUR E 2.5.1(A) (in part) DRAWBAND/BANDING SYSTEMS

Figure 25: An extract from AS4554.1

Labelling

- Labels on the outer jacket/sleeve of all insulated flexible ductwork in accordance with *Clause 2.7 of AS4254.1* must:
- Be repeated along the total length of the ductwork at 1000 mm intervals
- Include the following information:
    - Name of manufacturer
    - Compliance with AS 4254.1
    - The R value of the flexible duct.

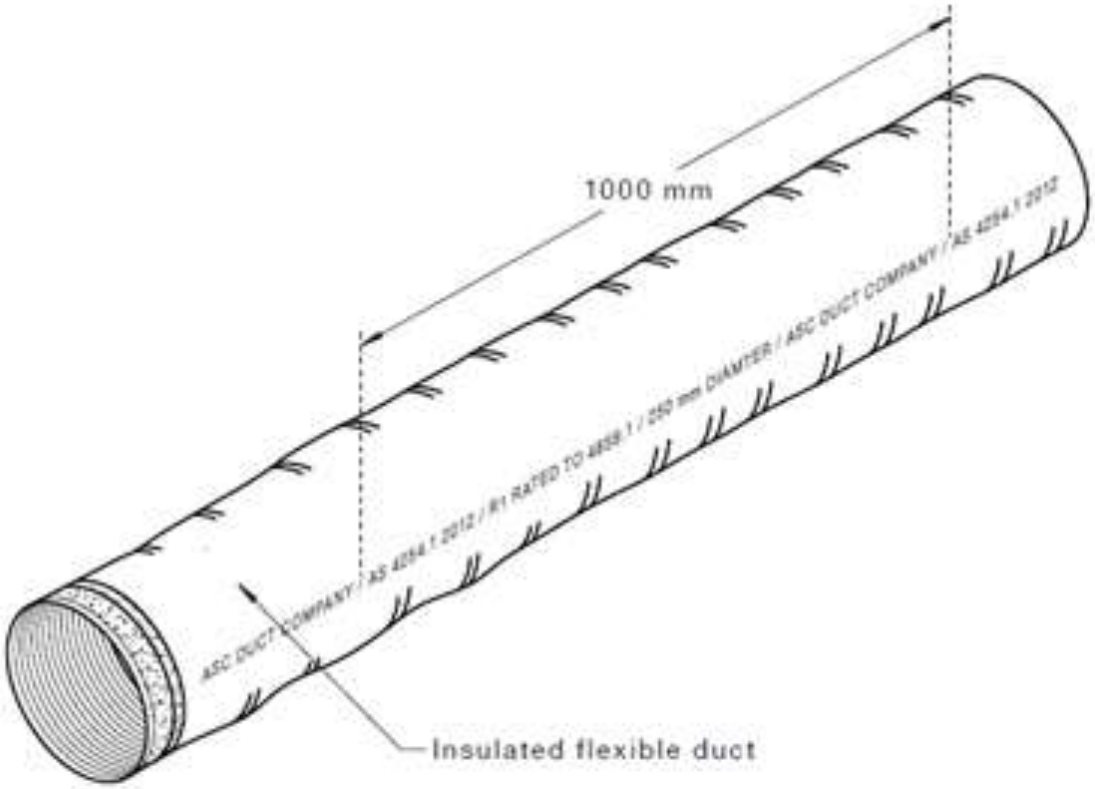


Figure 26: AS4254.1 Flexible duct labelling

Changes in Direction

- Flexible duct work must extend straight for 100 mm from the connection to an air terminal device prior to any change of direction.
- Flexible duct work must be installed with a minimum bend radius to flexible duct diameter of 1 to 1.
- Nude core (uninsulated) duct is only be used for exhaust systems such as toilet, general and miscellaneous exhausts, never for bathrooms, laundries or similar steam generating areas.

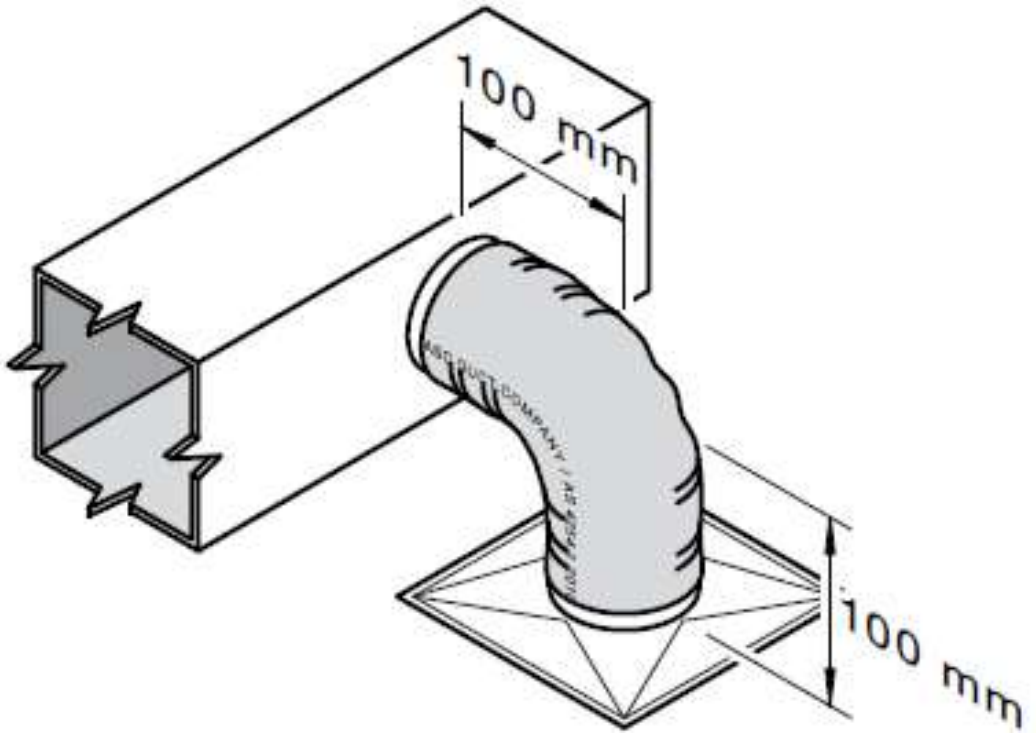


Figure 27: Figure 2.5.2(B)(a) AS4254.1 Flexible duct installation

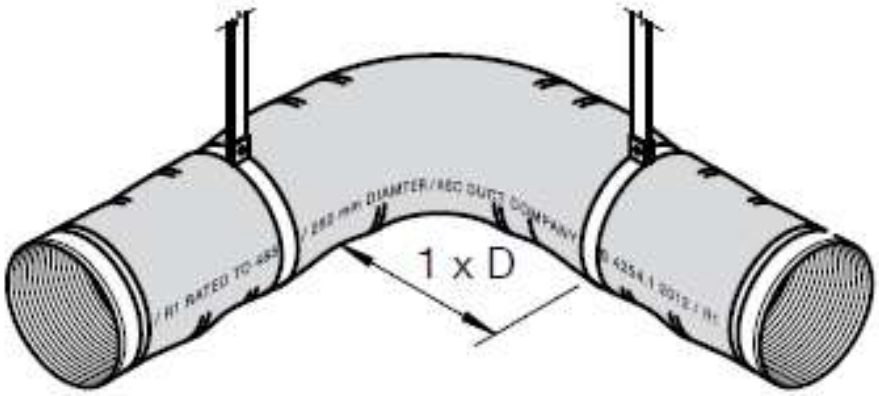


Figure 28: Figure 2.5.2(B)(b) AS4254.1 Flexible duct installation

1.1.3 Fire Dampers

Key considerations

- Compartmentation Plans - Fire & Smoke
- Fire Resistance Level (FRL)
- Element Material FRL (i.e. wall, floor, ceiling)
- Service Material FRL (i.e. penetrating a compartment, FRL)
- Fire/smoke stopping system (as per MPX schedule)

What are fire dampers?

- A penetration sealing device to maintain the integrity of the wall in the event of a fire.
- There are many different fire dampers including;
- Intumescent
- Curtain type
- Motorised
- In floor
- Single blade or drop lock
- Multi-blade and multi-blade motorised

Note: smoke dampers are the same as fire dampers, the only difference being they include tip seals and may be motorised

Why use fire dampers?

- When a rise in temperature occurs, a fire damper closes and prevent the spread of flame through the barrier. Fire dampers are typically mechanical being curtain, flap or blade type that closes when a fusible link melts. The fusible link typically melts when the temperature rises to 75 degrees Celsius.

Installation

Fire dampers must:

- Have an adequate clearance all around for expansion e.g. 1% + 10mm (refer Figure)
- Have mounting flanges must be twice the width of the expansion gap.
- Have combustibles kept clear, with 100mm clearance provided on all sides of the damper.
- Be installed in the correct orientation
- Have retaining angles must be butted against the face of the fire resisting structure and fixed to the fire damper.
- Have the space the fire damper body and the surrounding wall or floor shall be packed with high temperature, insulated packing material or as per as per evidence of suitability.

- Have the casing not protrude more than 150mm beyond the wall on either side.

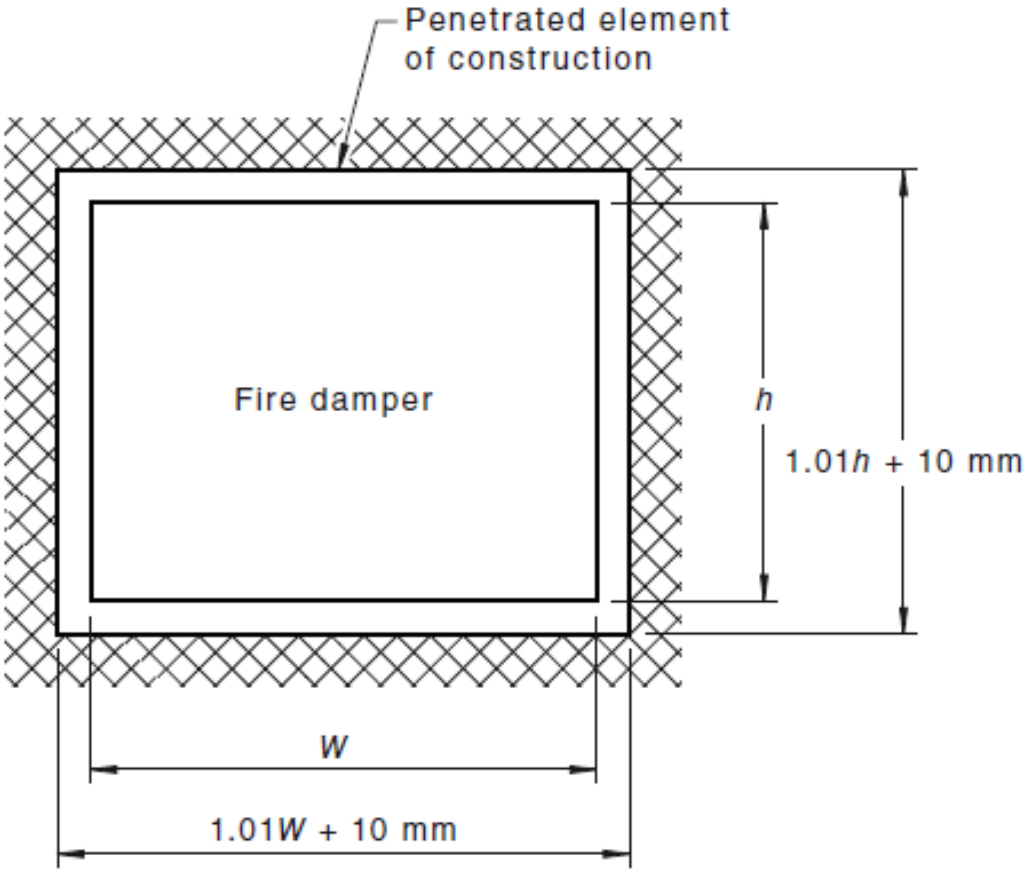


Figure 29: Annual Gap

Breakaway Joints

- Breakaway joints can be with a:
  - Flange connection installed with nylon/aluminium bolts or
  - Raw edge connection or
  - A slip joint.

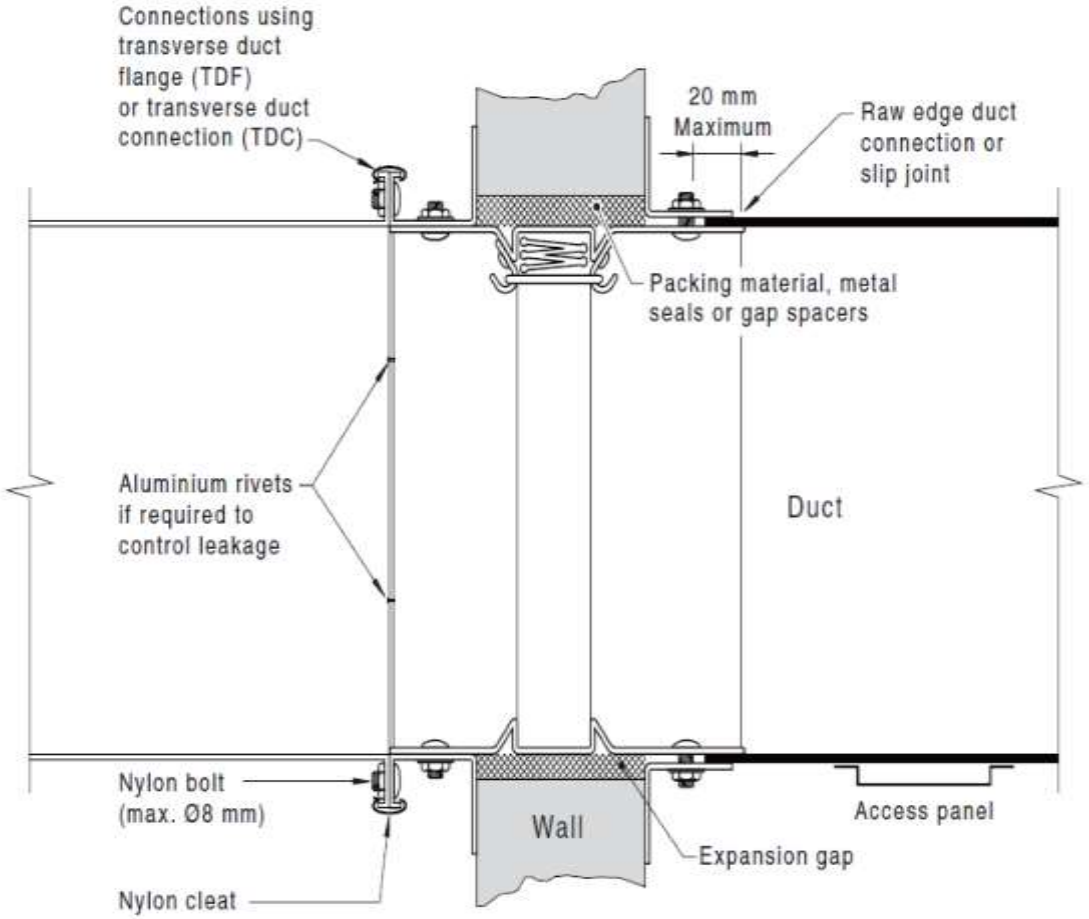


Figure 30: Fire Damper - Flange Connection

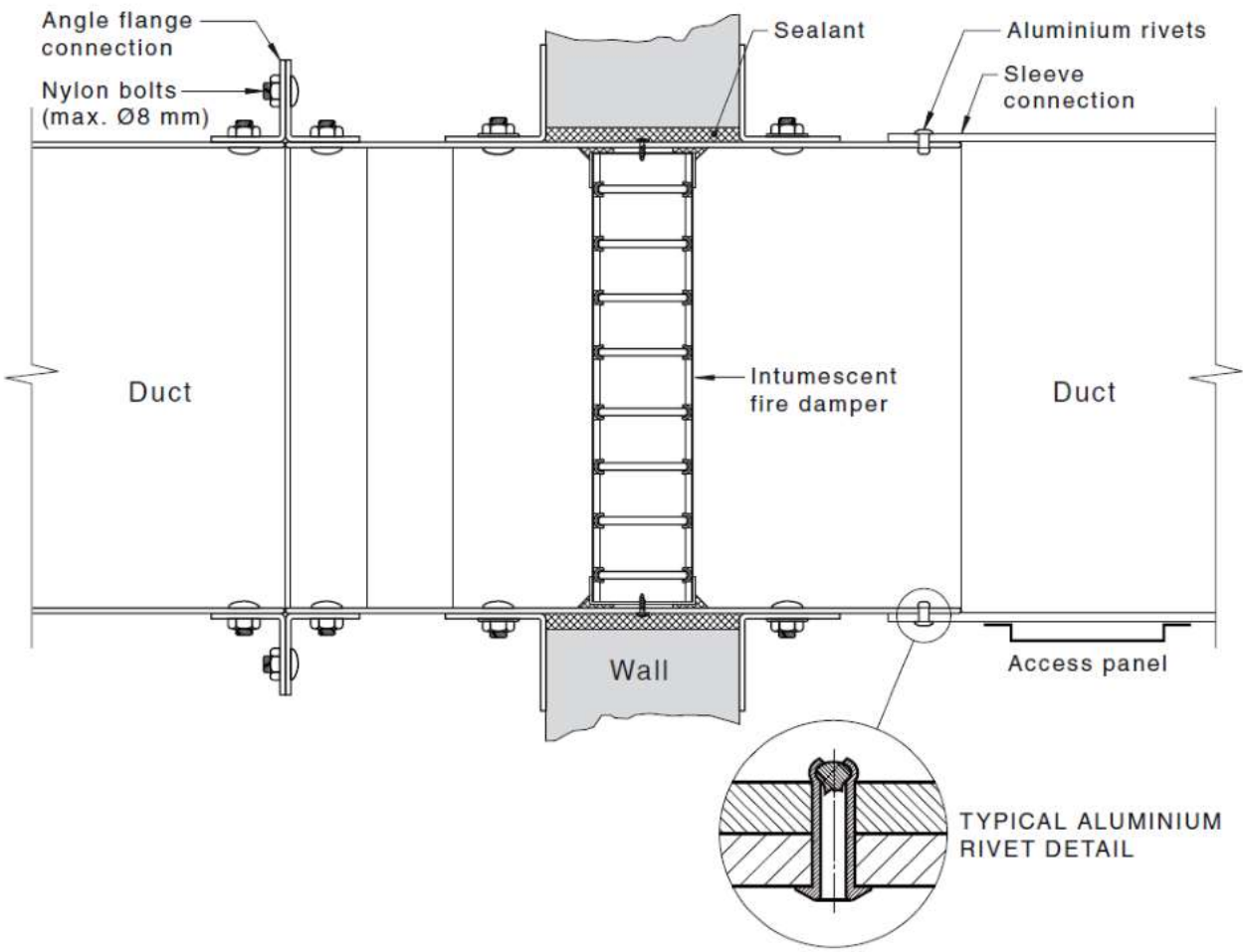


Figure 31: Intumescent Fire Damper - Raw Edge Connection

Labels

- Fire damper labels must be:
- Include details as per Figure including:
  - Installation Contractor
  - Name and licence number of the person installing the damper
  - Name and licence number of the person approving the damper
  - Date of installation
  - Make and model where manufacture label ins not visible
  - Reference identification code
- Installed in accordance with AS 1682.2 Clause 7.6.1 and 7.6.2
- Permanently fixed to the wall/floor/ceiling/slab close to the damper.

Documentation and Base Line Data

Documentation and base line data must be include:

- Identification of damper by number and location
- Floor plan drawings showing location of dampers
- Make and model number of each damper
- Name of installation company
- Date of installation
- Evidence of suitability
- FRL
- Commissioning sheets
- Photographs recording the installation of all fire dampers must:
- Be taken by the mechanical subcontractor before, during and after installation.

Access

Access panels to dampers must:

- Be provided in the duct and the walls, ceilings and shaft.
- Positioned and aligned directly below or in front of the damper (never offset or misaligned).

Figure 32: Example of ductwork access panel

1.1.4 Exhaust Systems

Commercial Systems

- Ductwork for commercial kitchens in accordance with *Clause 6.2 of AS1668.1* must have:
- Galvanized steel ductwork of a thickness not less than 1.2 mm or stainless steel not less than 0.9 mm
- Joints which are grease tight
- Fall towards the extraction hood
- Flexible connections which are grease proof and not longer than 300mm
- Ceiling access panels which provide unhindered access to the kitchen exhaust
- A grease proof plug for drainage at the bottom of the vertical shaft
- Clean out access panels large enough to enable cleaning of ducts which are located:
    - At the bottom of a shaft along the side of ductwork.
    - At every change of direction along the side or top of ductwork.
    - Every 3m in straight runs along the side or top of ductwork.

Kitchen exhaust systems must be:

- Protected with sprinklers when located in a building required to have sprinkler protection, and
- Have sprinklers installed under kitchen hoods and within kitchen exhaust ductwork.

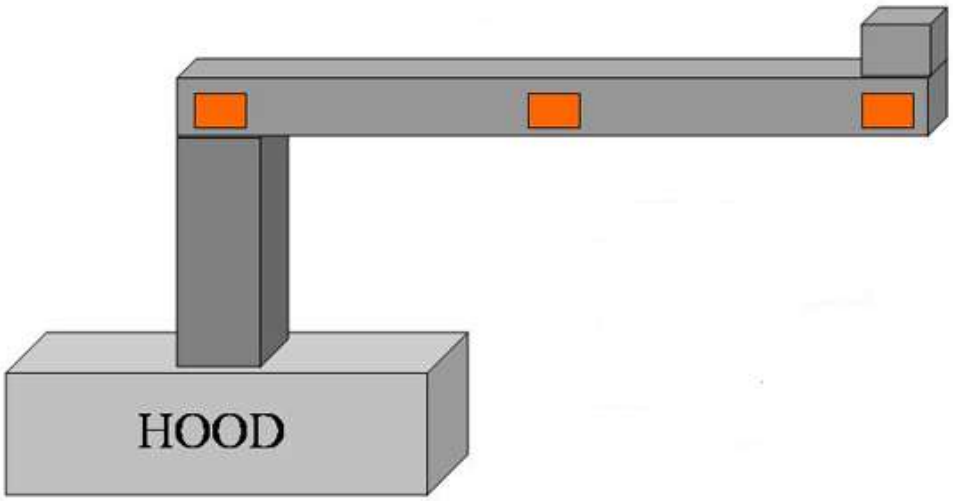


Figure 33: Access panels located every 3m and change in direction

Figure 34: Kitchen exhaust systems – drain plug

1.1.5 Shaft and Plenums

- Masonry or Hebel shafts or plenums used as a return air/exhaust plenum or stair pressurisation must be:
    - Bagged on the internal face to minimise air leakage
    - Checked for structural integrity.
- Other non-duct shafts (i.e. Speedpanel) used as a return air/exhaust, irrespective of all other requirement, must be sealed on the internal face to minimise air leakage.

1.1.6 Fan Coil Units

Condensate Drains

- Condensate drains must be installed with a:
- Positive fall
- 'P" Trap fitted and have an adequate fall
- Tundish that is:
    - Accessible
    - Visible (sometimes in wall tundish, box with visible panel is used).
    - Connected in the ways outlined in *AS/NZS 3500.2:2015 Clause 13.21*. (refer example below).
- *Drain* line that is *insulated* over the first 3m
- Drain trap that contains a transparent section to view flow
- Discharge pipe over a tundish with an air gap of a size at least twice the internal diameter of the discharging pipe.

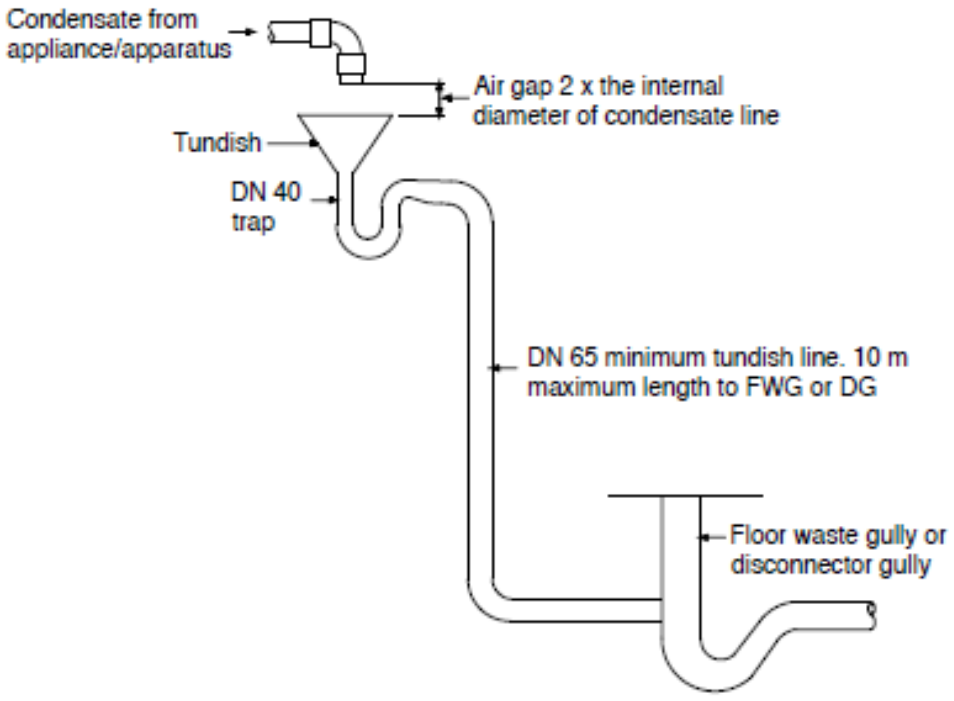


Figure 35: A fully vented modified, single stack or single stack modified. Maximum unvented length 2.5 m

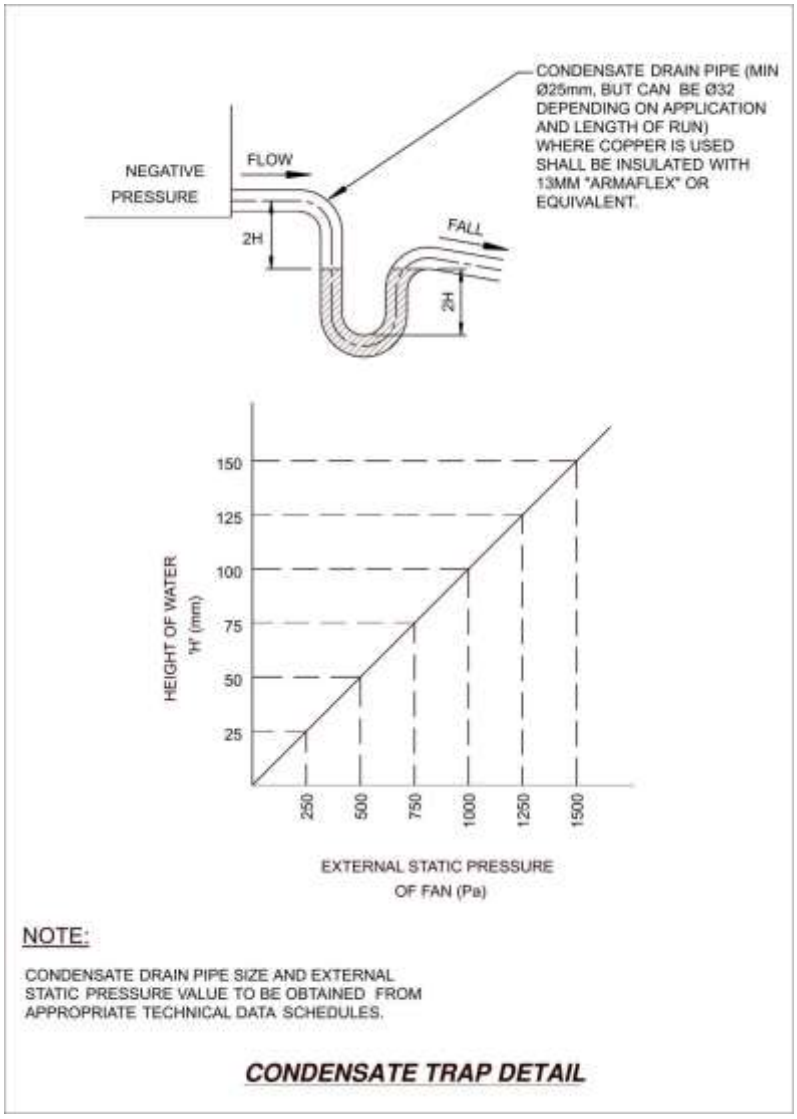


Figure 36: Safe tray condensate drain, MPX

Figure 37: Fan coil unit with condensate tray

Condensate Drain Test

- Condensate drains must be tested after the ceiling grid has been installed.

Connections

- Fan coil units in ceilings must be installed with:
- Approved vibration isolation from the structure on which they are mounted.
- Flexible connections between unit and rigid ducting.

Access

- Fan Coil Units (FCU) in ceilings must:
- Have a minimum access panel of 450mm x 450 mm
- Be installed to allow for adequate access unhindered for:
    - Routine maintenance
    - Removal of filters
    - Access to valves, motors, control box.

1.1.7 Air Handling Units

Access and Plinths

General plant (including Air Handling Units, boilers, chillers, pumps etc.) must be:

- Installed with adequate access on sides with maintenance access panels for ease of service and replacement.
- Mounted on plinths (minimum 100mm in height) which is membraned and sealed as per figure below.

Vibration

Air handling units and other general plant must be installed with approved vibration isolation from the structure on which they are mounted.

1.1.8 Mechanical Pipe Work

Materials

- Pipework used for the installation of mechanical systems must be approved and can be either copper, stainless steel, mild steel or HDPE.
- Pipework made from Acrylonitrile Butadiene Styrene (ABS) or Aquatherm (PP-R) must not be used.

Supports

- Pipework must be neatly set out, level and parallel with walls/other services.
- Support spacing of pipework must be located at centres in accordance with the following standards (which are summarised in horizontal pipe support spacing and vertical pipe support spacing) or where recommended by the piping materials manufacturer:
    - Steel pipe to AS 4041 Table 3.28.2.
    - Copper pipes to AS 4809 Table 6.2.
    - Other nonferrous pipe to AS 3500.1 Table 5.6.4.

Expansion Devices

Expansion devices for pipework must be:

- Detailed and installed as per approved shop drawings
- Installed as per manufacturer's specifications.

Insulation

Pipework must be insulated, including:

- Heat and chilled water piping and associated fittings
- Refrigerant suction lines
- Refrigerant liquid lines
- Condensate lines

UV Protection

- Pipework, conduits and insulation exposed to sunlight / ultra violet light must be UV stable or protected to prevent degradation.

Testing

- Pipework must be tested for a period of 2 hours minimum with a pressure of 1.5 times the working pressure of the system or as per specification.

1.2 Hydraulic Gas

1.2.1 Hot and Cold Pipe Work

Materials

- Pipework materials used for hot and cold water must be:
  - In accordance with the local authority and hydraulic consultants requirements.
  - Copper type B or
  - PEX (Rehau or approved equivalent) or
  - Stainless Steel
- Pipework made from Acrylonitrile Butadiene Styrene (ABS) or Aquatherm must not be used.

Below Ground Clearances

- Underground cold water service pipe must be separated from other services in accordance with *Clause 5.2.3 of AS3500.1* (outlined in chapter 'Below Ground Separation Distances').

Below Ground Clearances

- Underground cold water service pipe must be separated from other services in accordance with *Clause 5.2.3 of AS3500.1* (outlined in chapter 'Below Ground Separation Distances').

Bedding Materials

- Water services pipework installed below ground in accordance with *Table 5.10 of AS3500.1* must be:
  - Surrounded with not less than 75mm of compacted sand or fine-grained soil, with no hard-edged object in contact with or resting against any pipe or fitting.
  - Installed with underground pipe warning tape 150mm above all underground pipes for the full length of the pipe.

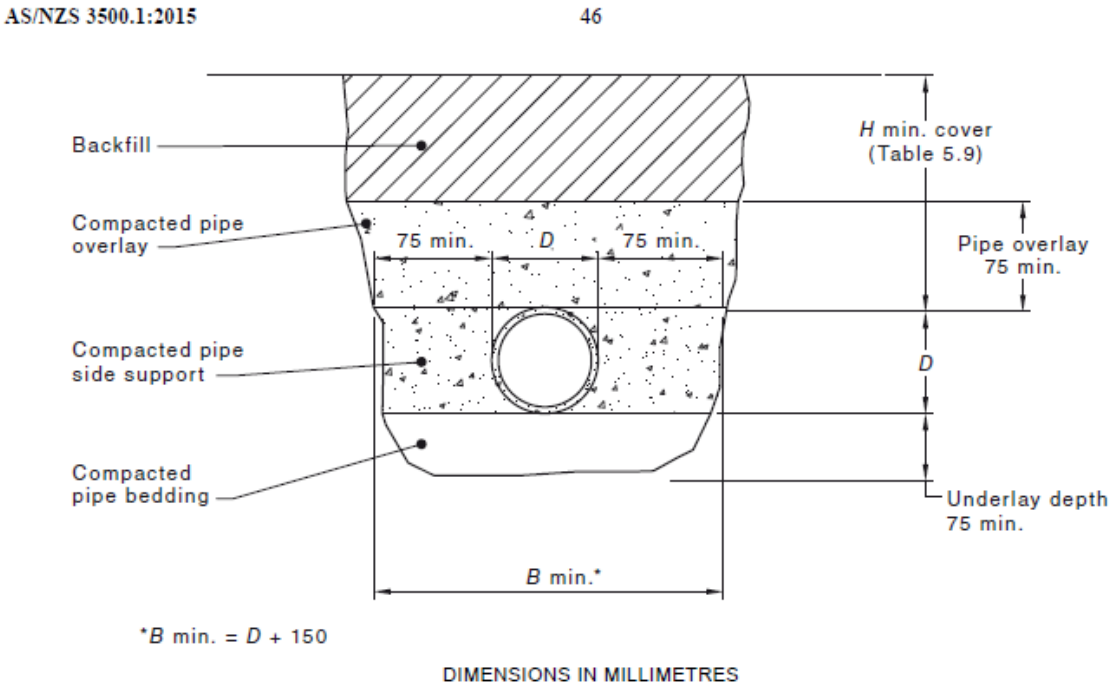


Figure 1:Table 5.10 from AS3500.1:2015, Typical trench installation

Cover

- Hot and cold water services installed below ground must have minimum depths of cover as outlined below:

Item	Under Slabs and Footing	General	Under Roads	Std Ref
Water Services	75	450	600	Table 5.9 AS3500.1
Hot Water Services - Public		450	450	Table 4.9.1 AS3500.4
Hot Water Services - Private Property	75	225	300	Table 4.9.2 AS3500.4

Below Ground Protection

- Copper pipes in accordance with *Clause 5.2 of AS4809* installed below ground must:
  - Be suitably protected against external corrosion by means of pre-insulated copper pipe, petrolatum-based wrapping or equivalent.
  - Have all joins wrapped with a durable inert waterproof tape.

Under Concrete

- Water service pipes laid under concrete in accordance with *Clause 5.4.4 of AS3500.1* must be:
  - Continuously lagged with an impermeable material
  - Laid in a narrow trench on a bed of sand or fine-grained soil placed and compacted.
  - A minimum distance of 75mm between the top of the pipe and the underside of the slab.
- Copper pipes laid under concrete in accordance with *Clause 6.2 of AS4809* must:
  - Be either Type A or Type B.
  - Be continuously lagged with an impermeable material.
  - Have all joins wrapped with a durable inert waterproof tape.
  - Have any pipework that penetrates the slab at right angles insulated with an impermeable flexible plastic material of not less than 6 mm thickness for the full depth of the slab penetration.

Casting in Concrete

- Copper pipes must not be embedded or cast into concrete structures
- PEX pipes embedded in a concrete must be:
  - Installed in an approved conduit.
  - Installed with no joints in the pipe.

Above Ground Clearances

- Pipework must be separated from other services in accordance with:
  - Clause 5.2.2 of AS3500.1 for cold water.
  - Clause 4.2.2.2 of AS3500.4 for hot water. (Refer chapter 'Above Ground Separation Distances').

Brackets and Supports

- Cold water services in accordance with *Clause 5.6 of AS3500.1* must be retained in position by brackets, clips or hangers that are:
    - Securely attached to the building structure and not to any other service
    - Clamped securely to prevent movement, unless designed to allow for thermal movement
    - Supported and fixed at the intervals specified in *Table 5.6.4. of AS 3500.1* – refer horizontal pipe support spacing and vertical pipe support spacing or manufactures specifications.
- Hot water services in accordance with *Clause 4.4 of AS3500.4* must be retained in position by brackets, clips or hangers that:
    - Are supported and fixed in accordance with the requirements outlined above
    - Allow movement due to thermal expansion and not cause damage or corrosion to the pipe.
- Copper pipes must be supported at spacings in accordance with *Table 6.2 of AS4809* which is outlined in horizontal pipe support spacing and vertical pipe support spacing.
- PEX pipes must be:
    - Supported at spacings in accordance with the manufacturer's specification
    - Protected with a rubber grommet to the stud where the pipe passes through, to prevent abrasive action between the stud and the pipe.

Corrosion

- Copper pipework in accordance with *Clause 5.2 of AS 4809* must be suitably protected against external corrosion by:
    - Using pre-insulated copper pipe or petrolatum-based wrapping or equivalent
    - Wrapping joints with a durable inert waterproof tape.
- Metallic pipes, metallic fittings or Type M multilayer copper pipes installed in a water service in corrosive areas must be protected externally in accordance with *Clause 5.12 of AS3500.1*:
    - With an impermeable flexible plastic coating
    - By placing in a sealed polyethylene sleeve or
    - By continuously wrapping in a petrolatum taping material.
- NOTE: Corrosive areas are those that contain substances such as any compound consisting of magnesium oxychloride (magnesite) or its equivalent, coal wash, acid sulphate soils, sodium chloride (salt), ammonia or materials that could produce ammonia.

Expansion Joints

- Expansion joints must be provided for all pipes in all locations as outlined in AS3500.4, Clause 4.12.3, approved drawings or manufacturer's specifications.

Testing

- Pipework must be tested for 1500kPa for 30 minutes in accordance with AS 3500.1 (cold water) and AS 3500.4 (hot water) or as per hydraulic specification whichever is greater.

1.2.2 Drainage and Sewer

Materials

- Materials and products used in sanitary plumbing and drainage systems must be as approved sample and in accordance with *Clause 2.3 of AS 3500.2*.

Below Ground Clearance

- Separation between other services must be in accordance with *Clause 3.6.3 of AS3500.2* (Refer chapter 'Below Ground Separation Distances').

Below Ground Backfill and Cover

Bedding Materials

- Filling materials used for bedding of drains must be one of the following:
    - Crushed rock, gravel screenings or similar recycled materials of nominal size of 7–10 mm
    - Cement mortar containing 1 part of Portland cement to 4 parts of sand by volume, thoroughly mixed with clean water to a workable consistency.
    - Free-running sand capable of passing through a 2 mm mesh sieve containing no clay, organic or any other deleterious materials.
- Sanitary drainage must be:
    - Surrounded with not less than 75 mm of compacted sand or
    - Fine-grained soil, with no hard-edged object coming in contact with or resting against any pipe or fitting.
    - Installed with underground pipe warning tape installed 150 mm above all underground pipes for the full length of the pipe.

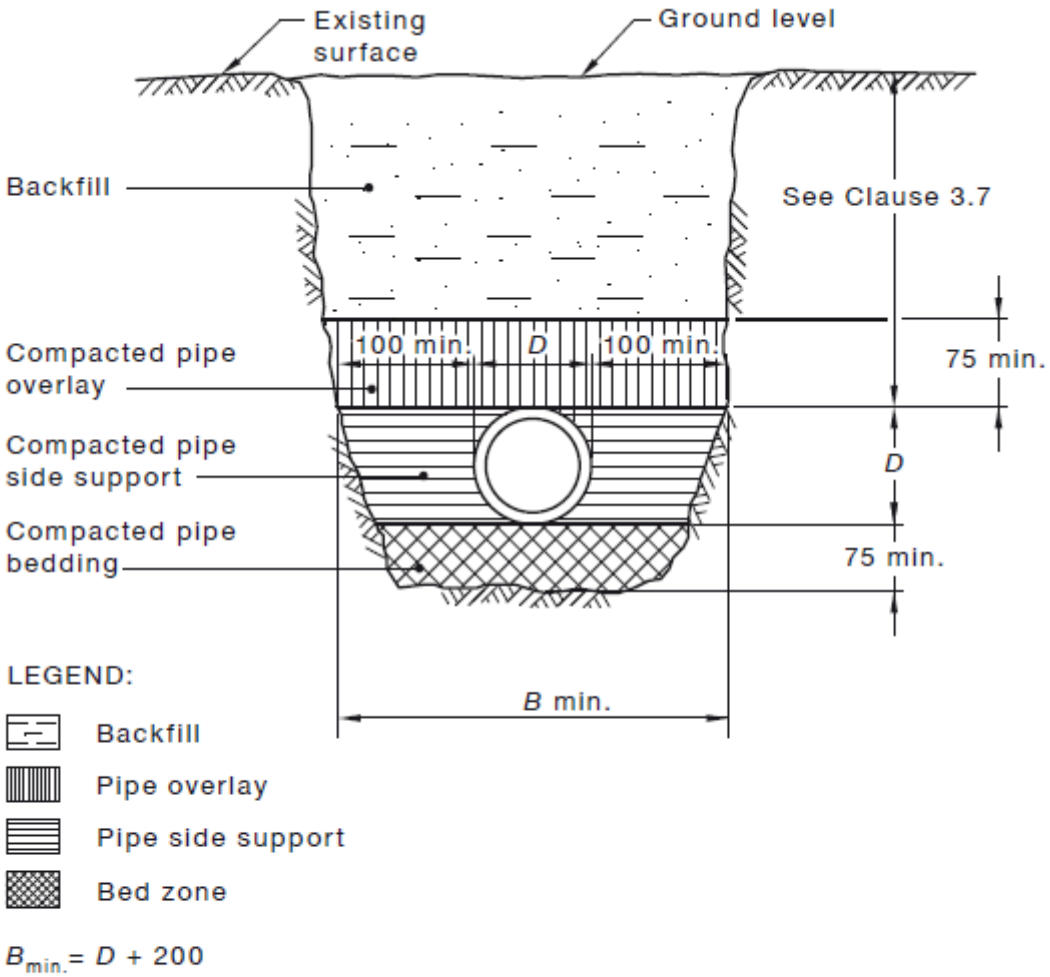
Backfill

- Backfill must be free from builder's waste, bricks, concrete pieces, rocks or hard matter larger than 25 mm and have no soil lumps larger than 75 mm.

Cover

- Drains must be installed with a minimum depth of cover, measured from the top of the pipe socket or inspection opening to the finished surface level, as specified in *Table 3.7.2 of AS 3500.2* outlined below.

Item	Under Slabs and Footings	General	Under Roads	Std Ref
PVC Pipes		300	600	Table 5.2 AS2032
Sewer		300	500	Table 3.7.2 AS3500.2



DIMENSIONS IN MILLIMETRES

FIGURE 5.4.4 TYPICAL BEDDING OF DRAINS

Figure 2: Figure 5.4.4 Typical Bedding of Drains – Extract AS 3500.2

Casting into Concrete

Plastic pipe in accordance with Clause 5.3.4 of AS2032 which is completely concrete encased must be fully wrapped prior to encasement with a compressible material with a nominal thickness of 6mm.

Above Ground Clearances

Separation from above-ground electrical conduit, wire, cable, gas or water pipes in accordance with Clause 3.6.2 of AS 3500.2 must be at least 100mm.

Brackets and Supports

Brackets, clips and hangers must be installed at the spacings as specified in horizontal pipe support spacing and vertical pipe support spacing.

Insulation

Insulation for above-ground sanitary plumbing pipework within residential buildings and hotels must be provided.

Protection of Drains

Drains are to be protected to stop construction waste entering and blocking waste pipes.

Figure 3: Example of cap used to stop construction waste entering a drain, Wondercap

Step up to Floor Wastes

- Sanitary drainage system floor waste as per AS3500.2 Clause 6.5.2.1 must be provided with step ups as per the below detail.

(b) The invert level of a trap or floor waste gully weir shall be a minimum of 10 mm higher than the soffit of the graded discharge pipe to which it connects.

NOTE: A typical connection is depicted in Figure 6.5.2.1.

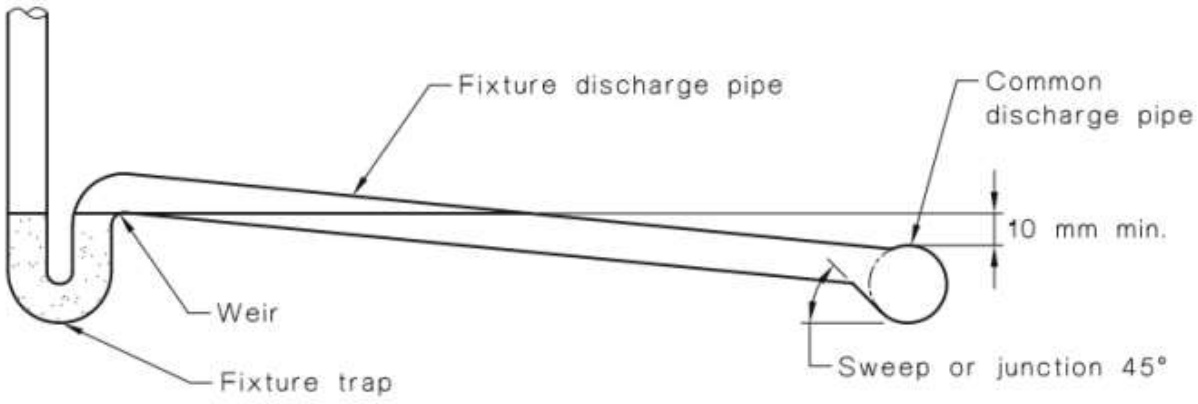


FIGURE 6.5.2.1 TYPICAL CONNECTION OF FIXTURE DISCHARGE PIPE TO A COMMON DISCHARGE PIPE

Figure 4: Floor Waste Step up Detail – Extract AS3500.2

Access for Maintenance

- Air admittance valves (AAVs), pressure attenuators, inspection openings must be accessible as required by AS3500.2 Clause(s) 6.9.3, 6.10.3.

Inspection Openings (Sewer Drainage)

- Except where inspection chambers are provided, inspection openings for maintenance purposes in accordance with Clause *4.7.1 AS3500.2* must be provided:
- Outside of buildings, not further than 2.5m along each branch drain connecting one or more water closets or slop hoppers
- At intervals of not more than 30m with a minimum of one inspection opening on each main drain
- At the connection to the network utility operator's sewer if not provided by the network utility operator
- On the downstream end of the drain where any drain passes under a building except where waste fixtures only are concerned
- Where any new section of drain is connected to an existing drain
- Immediately at or upstream of the upper bend of a jump-up.

Location of testing and inspection openings (general pipework)

- All common discharge pipes and stacks in accordance with *Clause 10.5.2 AS3500.2* must be provided with openings for inspection and testing in the following locations:

- In any common discharge pipe where necessary for inspection and testing.
- At the base of every stack.
- At any level of a stack where necessary for inspection and testing.
- At intervals not greater than 30m in every common discharge pipe.
- At every junction fitting that connects a common discharge pipe to a stack, or in the upstream section of the common discharge pipe.

Testing

- Sanitary plumbing and sanitary drainage installations must be tested:
    - Prior to the placement of the trench fill (backfill).
    - By hydrostatic, air pressure or vacuum testing to demonstrate that they are watertight in accordance with Clause 15 of AS 3500.2 or as per specification.
- CCTV acceptance inspection of sanitary drains must be conducted in accordance with the requirements of *AS 2032 Appendix E* or as per specification.

1.2.3 Storm Water Pipework

Materials

Materials and products used in stormwater systems must be as per approved sample.

Below Ground Clearances

Separation between any underground stormwater drain and other services must be in accordance with *Clause 6.2.6 of AS 3500.3* (outlined in 'Below Ground Separation Distances').

Below Ground Backfill and Cover

Bedding Materials

- Embedment material must comply with the relevant standards outlined below.
    - AS/NZS 2041.1 and AS/NZS 2041.2 for corrugated metal pipes
    - AS/NZS 2032 for PVC pipes
    - AS/NZS 2033 for polyethylene pipes
    - AS/NZS 2566.2 for flexible pipes and fittings
    - AS/NZS 3725 for FRC and reinforced concrete pipes.

Trench Fill and Backfill

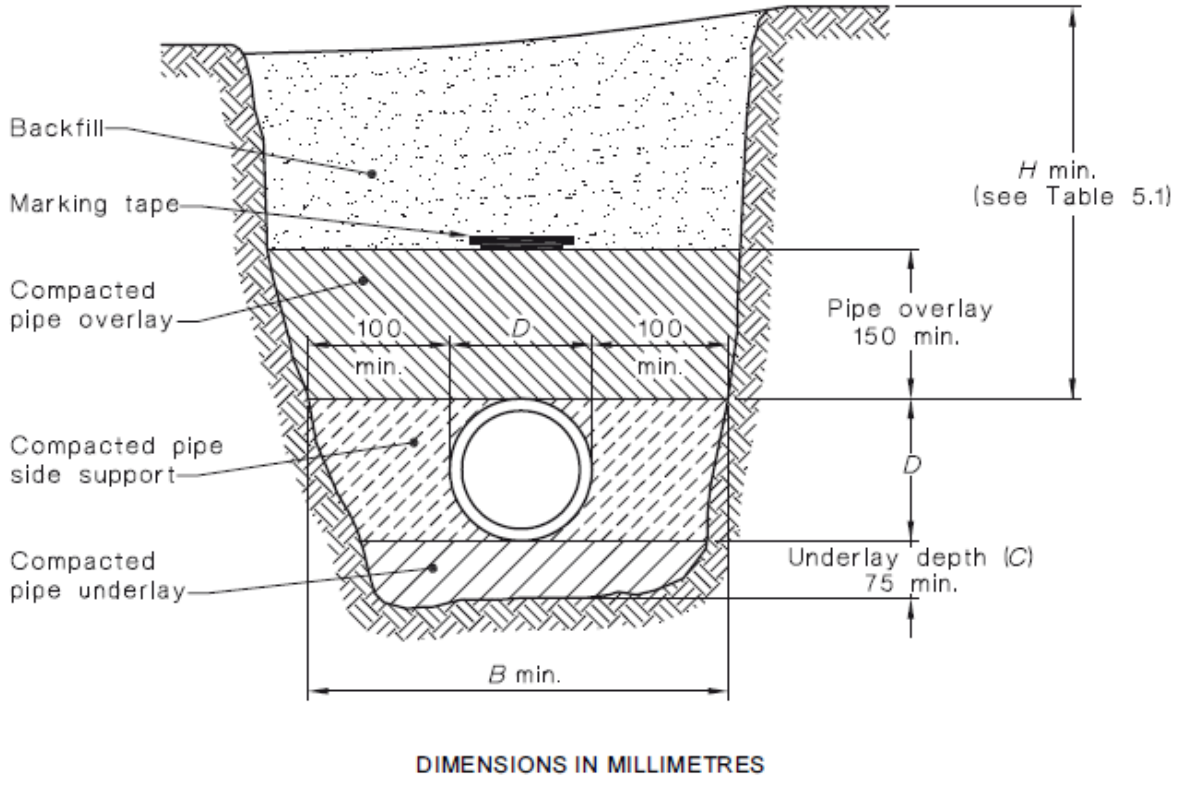
- Trench fill in accordance with *Clause 6.2.10 of AS 3500.3* must either*:*
    - be material excavated from the trench or imported, provided the material placed within 300mm of the top of pipes is free from builders' waste, bricks, pieces of concrete, rocks or similar material that would be retained on a 75 mm sieve or
    - be embedment material.
- Trench fill must be placed in loose layers not more than 200mm thick and compacted to not less than 90% or 95% under pavements of the standard maximum dry density.

Cover

- Cover must be not less than that given in *Table 6.2.5 of AS 3500.3* outlined below:

Item	Under Slabs and Footings	General	Under Roads	Std Ref
PVC Pipes		300	600	Table 5.2 AS2032
Stormwater		300	500	Table 6.2.5 of AS3500.3

- Underground plastic pipes in accordance with Figure 5.1 of AS2032 is to have a minimum of 100mm cover with the required depth of bedding, foundation material.



DIMENSIONS IN MILLIMETRES

Figure 5: Typical Installation of a Trench Figure 5.1 from AS2032:2006

Casting into Concrete

PVC pipe in accordance with *Clause 5.3.4 of AS2032* which is completely concrete encased must be fully wrapped prior to encasement with a compressible material to a nominal thickness of 6mm.

Brackets and Supports

Brackets, clips and hangers must be installed at the spacings specified in chapter 'Horizontal Pipe Support Spacing' and chapter 'Vertical Pipe Support Spacing'.

Above Ground Clearances

Separation between any above-ground stormwater drain and other services must be in accordance with chapter Above Ground Separation Distances.

Protection and Pits and Drains

Drains and pits must be protected from physical damage and construction waste entering the system.

Box Gutters

Refer this link to access Metal Roofing section of the handbook.

Stormwater Pits

Stormwater pits must be installed on a stable, well-compacted foundation to avoid future settlement (subsidence).

Siphonic Roof Drainage

- Siphonic roof drainage systems inclusive of design, pipes and fittings, bracketing, roof outlets and installation should be:
    - Designed by a qualified engineer
    - Installed by a siphonic specialist contractor
- Siphonic rainwater outlets must:
    - Be made of robust materials, suitable for the installed location
    - Incorporate leaf guards to restrict the entry of debris into the system without restricting the flow.

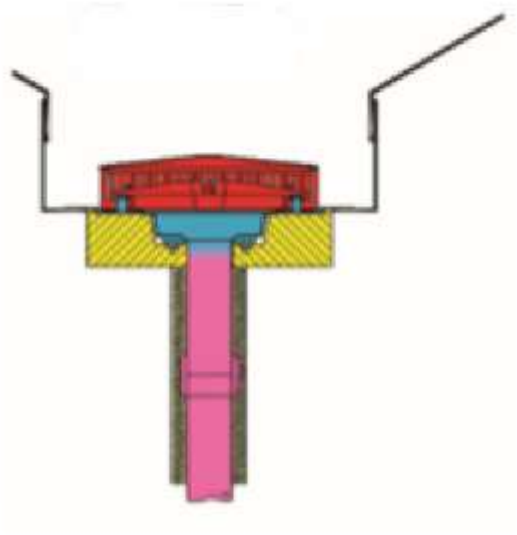


Figure 6: Siphonic gutter detail and carpark detail

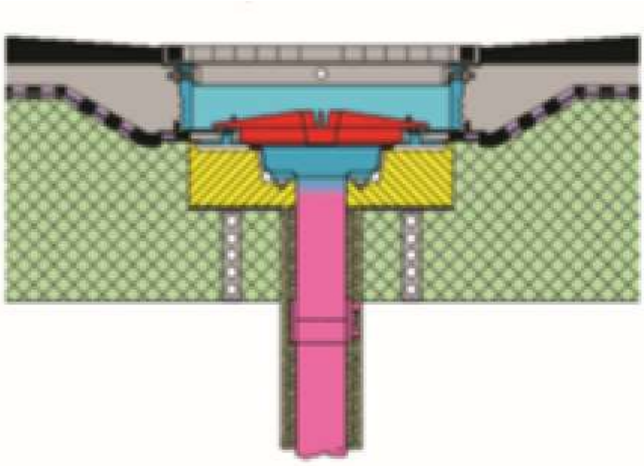


Figure 7: Siphonic gutter detail and carpark detail

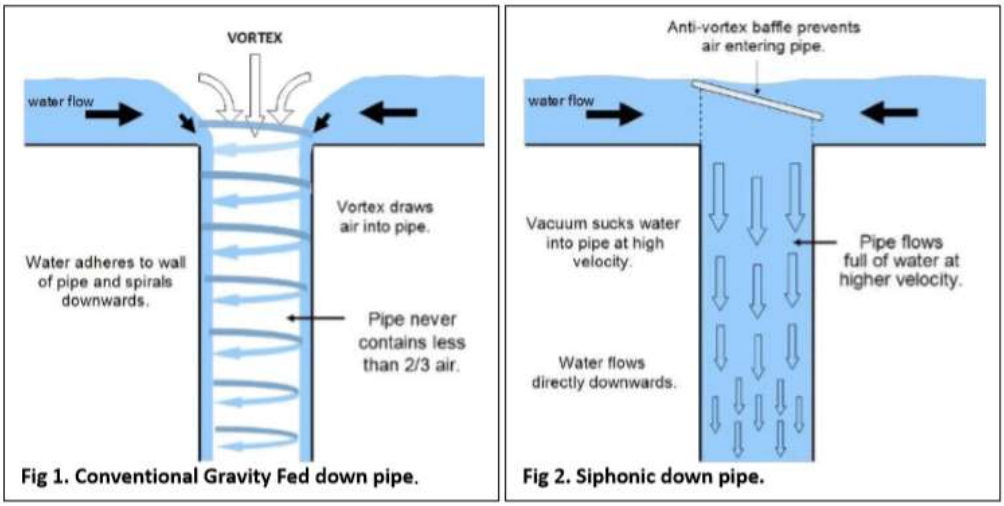


Figure 8: Siphonic drainage details

Subsoil Drainage

- Subsoil drainage pipe must be slotted UPVC or perforated, ribbed HDPE to *AS2439.1*
- Subsoil drains as required by *AS3500.3 clause 6.4.1* must be laid:
    - With clean-out points for pipes.
    - With a 50mm minimum pipe underlay of filter material in the trench to take out any irregularities in the trench bed and provide a drainage path underneath subsoil drain.
    - With an appropriate filter material aggregate (13mm max).

1.2.4 Natural Gas

Materials

- Gas pipework must be:
- Metal from the authority meter location to the entry to the building and in risers and branch lines
- As per approved sample throughout the building.

Below Ground Clearances

- Separation between other services must be in accordance in with 'Below Ground Separation Distances'.

Below Ground Backfill and Cover

- Cover must be not less than that given in the Table outlined below.

Item	Under Slabs and Footings	General	Under Roads	Std Ref
Gas	300 (metallic) 450 (non-metallic)	650	750	Table 4.5 of AS5601

- Metal gas pipes which are permitted to be used in the ground for gas in accordance with *Table 4.1 of AS 5601.1:2013* must be:
    - Coated or covered with a proprietary wrapping.
    - Installed with underground pipe warning tape and trace wire 150mm above all underground pipes for the full length of the pipe.

Above Ground Clearances

- Separation between other services must be in accordance with 'Above Ground Separation Distances'.

Casting into Concrete

- Copper pipes must not be embedded or cast into concrete structures
- PEX pipes embedded in a concrete must be:
    - Installed in an approved conduit.
    - Installed with no joints in the pipe.

Brackets and Supports

- Gas pipes must be supported at spacing in accordance with 'Horizontal Pipe Support Spacing' and 'Vertical Pipe Support Spacing'.
- Diameter of rod hangers must comply with the Figure 9.

TABLE 4.3

DIAMETER OF ROD HANGERS

Nominal size (DN)	Minimum rod diameter for single rod hangers (See Note) mm
up to 50	9.5
65 to 90	12.7
100 to 125	15.8
150 to 200	19.0

Figure 9: Table 4.3 of AS5601 Diameter of Rod Hangers

Piping in an air duct, plenum ceiling, air handling plenum or ventilating duct

- Consumer piping as per *Clause 4.10.17 of AS5601* in an air duct, air plenum ceiling, air handling plenum or ventilating duct must:
    - Have an operating pressure not exceeding 7 kPa
    - Keep number of joints to the minimum
    - Have all permanent joints.

Gas Piping in Concealed Locations

- Gas piping in concealed locations must be in accordance with Table 4.6 of AS 5601 outlined below:

4.10.18 Piping in a concealed location other than underground or embedded in concrete

Where *consumer piping* is to be in a concealed location, other than underground or embedded in concrete, the requirements detailed in Table 4.6 shall apply.

TABLE 4.6

PIPING IN CONCEALED LOCATION

Operating pressure	Accessibility (Note 1)	Ventilation required? (Note 2)	Pipe materials and jointing
Up to and including 7 kPa	Accessible	Yes	Pipes and jointing as per Table 3.1
	Inaccessible	Yes	Pipes as per Table 3.1 Joints to be kept to a minimum
	Accessible or Inaccessible	No	Pipe as per Table 3.1 Joints to be *permanent joints* and kept to a minimum
Exceeding 7 kPa	Accessible	Yes	Pipes as per Table 3.1 Joints to be *permanent joints* and kept to a minimum
	Inaccessible	Not to be installed	

NOTES:

1 In this Table *accessible* means access can be gained by, for example, a ceiling access opening or sub-floor door except that in a multi-storey building it means able to be viewed at each floor.

2 For ventilation requirements see Clause 4.10.21.

Figure 10: Table 4.6 of AS5601 Piping in Concealed Locations

Testing

- Pressure test the gas pipework to 3 times the working pressure with compressed air for 5 minutes.

1.2.5 Seismic Restraint

Seismic restraints/bracing in accordance with AS1170.4 - 2007 must be:

- Detailed and installed as per approved shop drawings
- Installed for the following hydraulic and gas services:
    - Boilers, furnaces, incinerators, water heaters and other equipment using combustible energy sources or high energy sources, chimneys, flues, smokestacks, vents and pressure vessels.
    - Suspended reticulated services 65mm in diameter and above and gas services 25mm and above, installed 300mm or lower below the fixed point to the structure.
- Separation between restrained and unrestrained services must be in accordance with the table below:

Condition being considered	Minimum clearance	
	Horizontal	Vertical
Unrestrained component to unrestrained component (where allowed by AS1170.4 - 2007)	250mm	50mm
Unrestrained component to restrained component	150mm	50mm
Restrained component to restrained component	50mm	50mm
Penetration through structure such as walls or floor	50mm	50mm
Unrestrained services passing through the ceiling	25mm	25mm
Sprinkler heads with flexible droppers	nil	nil
Note: Ceiling hangers and braces are considered to be restrained components for the purpose of this table, hence 150mm horizontal clearance is required between ceiling hangers and unrestrained services.		

Figure 11: Guide to the Minimum Clearances – Extract form NZS 4219

1.3 Electrical

1.3.1 HV and Substations

- High voltage cabling systems must be installed in accordance local authority requirements and Australian Standards.

General

- Substations must be:
    - Constructed strictly in accordance with the approved specifications and drawings provided by the ASP 3 designer for authority substations and the electrical design for private substations
    - Constructed with consideration to the following requirements as examples of that which is required to be provided:

Cable Entry Ducts and Conduits

- Cable entry ducts, including both unused ducts and ducts containing cables must be sealed against water entry.
- Conduit used in the substation chamber must have:
    - Conduits of suitable diameter and conform to *AS/NZS 2053.2:1995* (colour orange, minimum conduit classification "HD").
    - Joints socketed and solvent welded.
    - Bends complying with Ausgrid Appendix E of NS130 or similar as required by the local AHJ.
    - No elbows
    - Edges pencil rounded to minimise damage to the cables when entering pits or the substation chamber.
    - 150mm concrete encasement for authority chamber substations.
- Note: 'Corflo' type conduits or equivalents, including 'sandwich construction' conduits, are not to be used in substation chambers or for mains entry to substation chambers.

Structure and Fire Rating

- Concrete finish must be Class 2 or better.
- Entire chamber substation must achieve an FRL of 180/180/180 unless otherwise approved in FER and withstand a blast rating of 2kPa.
- Permanent steel ribbed formwork such as “Bondek” left permanently in place must be fire rated unless it does not form part of the structural adequacy of the ceiling.
- Post-tensioned construction wire strands forming the tensioning and all anchor mechanism must be fully protected to achieve a fire rating equal to the remainder of the substation chamber.
-

Earthing

- Electrode type earthing system must be installed directly under the footprint of the substation chamber or as per the approved drawings.
- Earthing electrode system and cables connecting the electrodes must be:
    - Installed before any waterproof membranes are laid and before the covering floor slab is constructed.
    - Provided with a puddle flange brazed to each electrode that is cast into the floor slab to ensure no water ingress.
- Earth electrodes must be:
    - Installed at no less than 3m apart
    - Connected into A group and B group using a cable type earth grid.

- Earthing system must:
    - Be protected from damage during construction.
    - Be a standalone type not connected to building reinforcement bars or grading rings.
    - Be well clear of building lightning protection systems.
    - Not be connected to the earth bar of any switchboard other than the earth bar inside the substation chamber.

Painting

- Ceiling and walls of the substation and associated chambers must be:
    - Painted with a coat of acrylic based filler/sealer.
    - Followed by two coats of white low sheen wash and wear acrylic based paint.
- Exposed un-galvanised metal must be:
    - Primed with an appropriate etch primer
    - Finished in two coats of grey paint, either enamel of acrylic based.
- External doors can be finished in colours to suit the building décor.
- Internal doors must be finished in two coats of grey paint, either enamel of acrylic based.
- Louvres can be finished in colours to suit the building decor, however if they must be left in natural aluminium they must be:
    - Finished with a grade A coating of clear anodising.
    - Followed by a coat of clear methacrylate lacquer or equivalent.

Water Service

- Water service must:
    - Be installed on the wall within the personal access chamber adjacent the sump pit or adjacent the chamber entry, generally within 5m of the entry.
    - Consist of a 20mm OD copper pipe, with wall thickness of 1.4mm, using brazed Yorkshire fittings.
    - Installed in accordance with the Authority drawings and the appropriate Australian standards.
    - Be connected to the substation earthing system.
- An accessible control valve must be installed and only a short length of pipe must be exposed along the wall.

Access an Right-of-Way Paths

- Access to chamber substations is to include:
    - Unimpeded 24 hour access seven days a week from a public roadway or area.
    - Access way must be capable of supporting a heavy vehicle or crane.
    - Internal access ways that comply to BCA and supply authority fire resistant construction requirements and fire segregation requirements.
    - Openings that comply with Local Authority requirements.

Figure 1: Chamber Substations, MPX

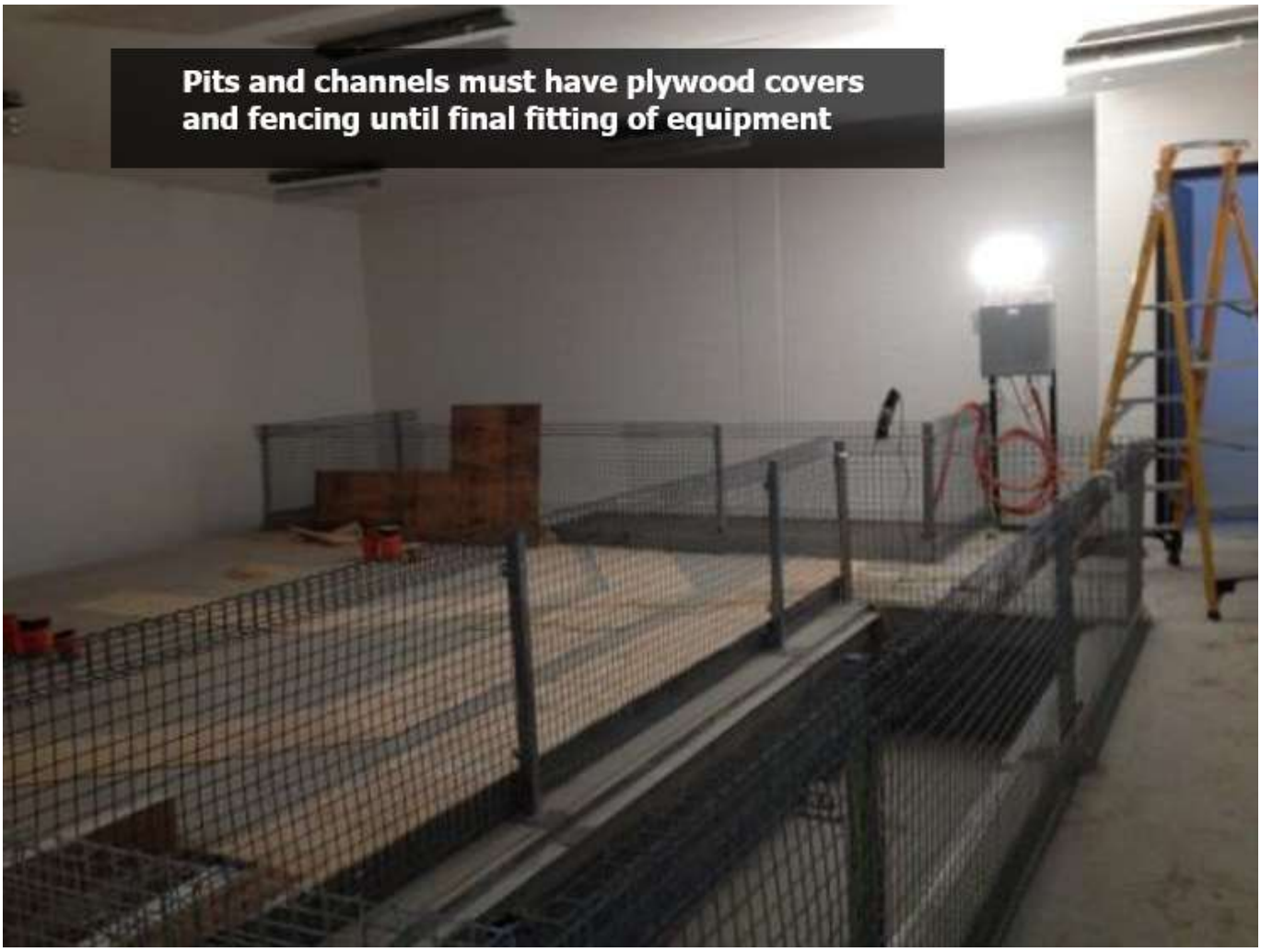


Figure 2: Chamber Substations MPX

1.3.2 Electro Magnetic

Shielding must be:

- Installed in accordance with the approved drawings.
- Provided by installing overlapping small gauge carbon steel sheets on the walls, floor and soffit of the room containing the source of the EMI and be earthed.
- Located external to the authority chamber substations.

Figure 3: Carbon steel sheets being installed on walls & floors

1.3.3 Low Voltage Cables

Electrical Depth and Cover

- Underground wiring systems must be installed with the minimum depth of cover and protection specified in *Table 3.6 of AS3000.*
- *Cat C system is one in which the wiring system is laid within a channel chased in the surface of rock.*

TABLE 3.6

UNDERGROUND WIRING SYSTEMS—MINIMUM DEPTH OF COVER

Location of wiring system	Covering on surface of ground above wiring system	Cat A system	Cat B system	Cat C system
Within confines of a building	Poured concrete of 75 mm minimum thickness	0 mm (directly below)	0 mm (directly below)	0 mm (directly below)
	No surface covering or less than 75 mm thickness of concrete	500 mm	500 mm	50 mm
Elsewhere external to a building	Poured concrete of 75 mm minimum thickness	300 mm`	300 mm	50 mm
	No surface covering or less than 75 mm thickness of concrete	500 mm	500 mm	50 mm

Figure 4: Table 3.6 of AS3000

Notes:

- Cat A system is one where the wiring system is inherently suitable for installation below ground and no further mechanical protection is required.
- Cat B system is one where the wiring system is suitable for installation below ground only with additional mechanical protection provided for the cable or cable enclosure.

Below Ground Clearances

- Wiring systems installed below ground must:
  - Maintain separation from other services in accordance with *Table 3.7 of AS3000* (summarised in below ground separation distances).
  - Use HD PVC conduits for all underground cable runs.

Services Crossover

- Separation distances outlined in below ground and above ground or as per manufactures specifications must be maintained where services cross over.

Above Ground Clearances

- Wiring systems installed above ground must maintain a separation from other services in accordance with above ground separation distances.
- Electrical equipment, including switches, socket-outlets and other accessories, in accordance with *Clause 4.2.2.6 of AS 3000* must be:
  - Arranged to provide a separation of not less than 300mm horizontally

- Positioned 600 mm vertically from any opening or recess in the opposite side of a wall, ceiling or floor that is required to be fire-rated.

Conduits - In Concrete

- Conduits which are completely concrete encased must:
  - Be installed with adequate separation and be bunched in accordance with the Structural and Electrical Engineers' requirements.
  - Have a minimum clearance of 1.5 x times the size of aggregate.
  - Be steel or HDPE in high strength concrete (anything over 40MPa). Note: avoid casting in conduits in high strength concrete if possible.

Fixing and Supports

- Fixings and cable support systems must be installed as per manufacturer's specification.

Pits

- Electrical pits to be labelled, free of debris and sitting on a gravel bed of no less than 300mm and / or provided within drainage to the stormwater system.

1.3.4 Fire Rated Cables

- Fire rated cable/s must be:
  - Supported on suitable fire rated metallic cable trays
  - Fastened with non-flammable rated materials such as steel ties, clips or similar at not less than 0.9m intervals horizontal and 0.6m vertical, or as per the manufacturer's recommendations and tested system.
- Fire rated wiring in new or altered works include wiring to:
  - Switchboards sustaining NCC emergency equipment (switchboards need to be in an equivalent fire rated enclosure)
  - Smoke control equipment
  - Motorised fire damper
  - Electrical fire pumps
  - Lifts
  - NCC essential electricity mains (unless otherwise fire rated by being run below ground).
- Note: All the above are NCC essential safety measures

Figure 5: Emergency Systems Cabling, Stainless steel cable ties to the right, Google Images

1.3.5 Lightening Protection

- The lightning protection / earthing system must consist of a Faraday cage system to AS requirements with:
    - Air terminals (lightning rods or tinned copper tape mounted on the parapet) installed at the highest parts of the building connected together and taken down through the building to an earth point in the ground.
    - Down conductors (generally being perimeter columns) which:
        - Include either steel reinforcing bars that are a continuous length with two (2) welded bars per column or Dedicated cables.
    - Have been tested for continuity by the electrical contractor as the structure progresses and prior to completion.
    - Have earthing points that are in an accessible location.
- Connection to all metal equipment or materials (mechanical plant, aerials, etc. on the roof) can be by tinned copper strap linking to the remainder of the lightening arresting system and linking to the down conductors.

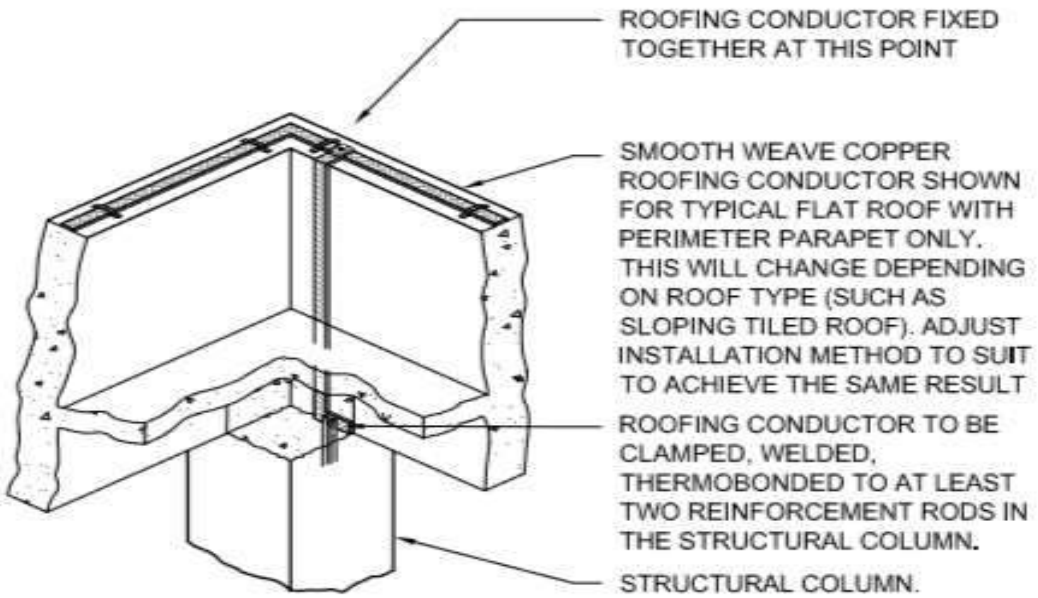


Figure 6: Roof Perimeter Conductor Connection to Structural Column Details

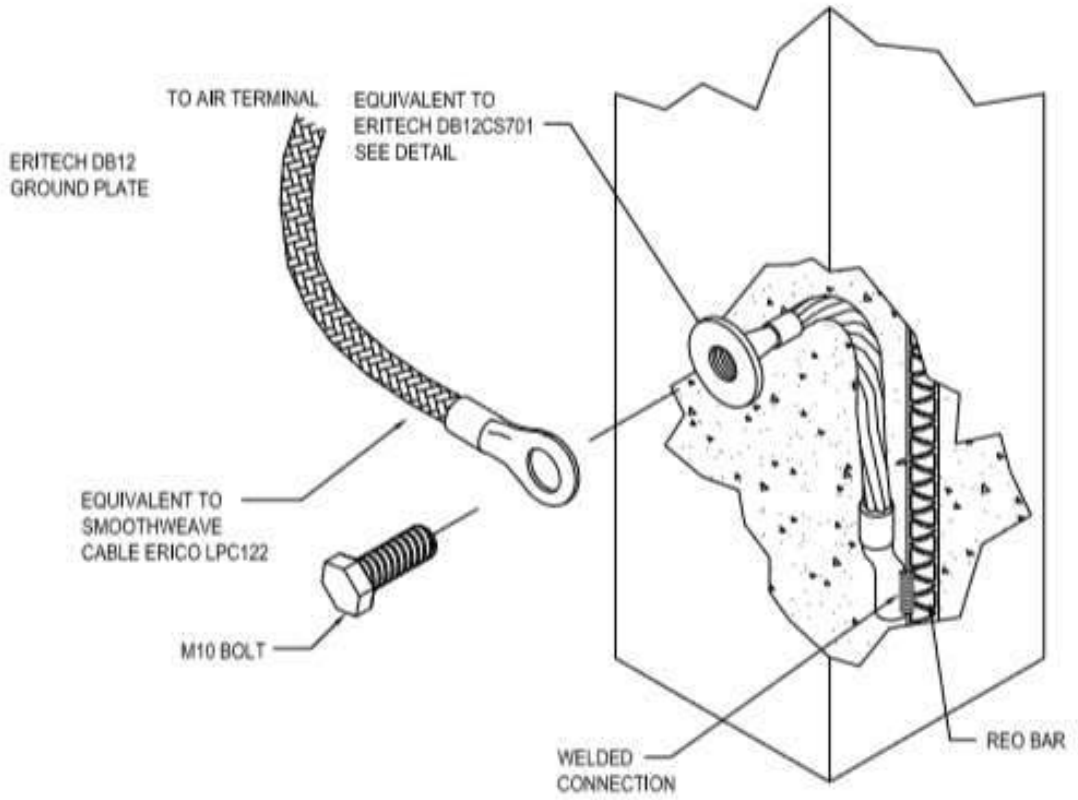


Figure 7: Typical Bonding Columns and Smoothweave Cable Lightning Protection Details

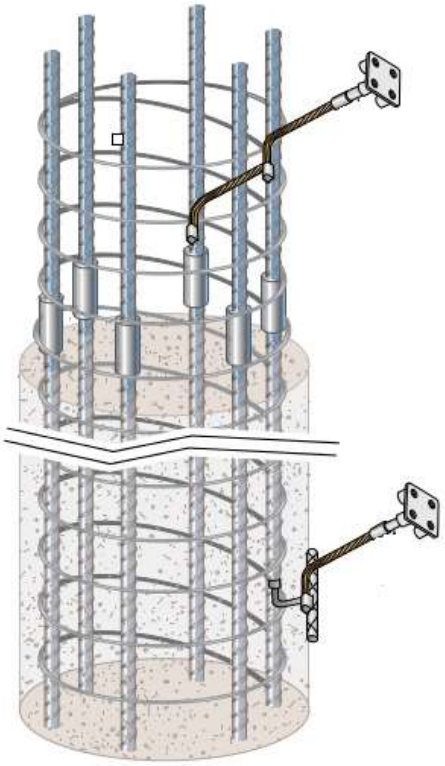


Figure 8: Connection details to columns

1.3.6 Seismic Restraint

- Seismic restraints/bracing in accordance with AS1170.4 – 2007 where required must be:
    - Detailed and installed as per approved shop drawings.
    - Installed for the following electrical services:
        - Emergency electrical systems (including battery racks)
        - Life safety system components
        - Lighting fixtures
        - Cable support systems
        - Electrical main switchboards, panel boards and dimmers
    - Installed 300mm or lower below the fixed point to the structure where the suspended reticulated services are 65mm in diameter and above.
- Seismic restraints/bracing on do not need to be installed on electrical conduit with less than a 64mm inside diameter.

1.4 Communications

Below Ground Clearances

- Communication systems installed below ground must:
    - Maintain a separation from other services in accordance with below ground separation distances or manufacturer's specification.
    - Be in dedicated telecommunications white conduit.
    - Have spare conduits labelled, equipped with draw wire and be sealed at both ends.
    - Maintain a separation from LV or HV power cabling in accordance with the *Table 4 of AS/CA S009:2013* outlined below (i.e. underground customer cabling separation from power cabling).

Below Ground Cover

- Comms pits to be labelled, free of debris and sitting on a gravel bed of no less than 300mm and / or provided within drainage to the stormwater system
- Communication services installed below ground must have minimum depths of (refer table):

Item	Under Slabs and Footings	General	Under Roads	Std Ref
Telecommunications		450	600	

Above Ground Clearances

- Communication systems installed above ground must maintain a separation from other services in accordance with above ground separation distances or manufacturer's specifications.

Services Crossover

- Separation distances illustrated at the end of the handbook or as per manufactures specifications must be maintained where services cross over.

Cable Supports

- Communication cabling must:
    - Be installed in accordance with the cable manufacturer's instructions.
    - Be supported on cable trays, catenary supports or baskets.
    - Be strapped to the soffit which must:
        - Have no more than 24 cables bunched together or as per manufacturer specifications.
        - Have spans between soffit clips sufficient such that cabling does not sag in between clips.
    - Have approved cable fasteners installed:
        - At intervals that comply with *Table 8.1 of AS/NZS 3084*.
        - In accordance with the manufacturer's specified spacing.
        - Using velcro fastening type. Nylon/zip style cable ties are not to be used.

TABLE 8.1

RECOMMENDED DISTANCE BETWEEN SUPPORTS FOR HORIZONTAL AND VERTICAL CABLE RUNS

	Cable size	Horizontal run mm	Vertical run mm
Twisted pair Cables	2–6 pair	200	500
	10–25 pair	300	500
	35–100 pair	300	800
Optical fibre cables	Up to 24C	500	1000
	>24C	500	2000
Earth cables	2.5–6 mm^2	200	500
	16–35 mm^2	300	800

Figure 1: Table 8.1 of AS/NZS 3084 Recommended Distances between Supports

Seismic

- Seismic restraints/bracing in accordance with AS1170.4 - 2007 must be:
  - Detailed and installed as per approved shop drawings.
  - Installed for communications systems such as cable systems, motor control devices, switchgear, transformers and unit substations.
- Separation between restrained and unrestrained services must be in accordance with the table below:

Condition being considered	Minimum clearance	
	Horizontal	Vertical
Unrestrained component to unrestrained component (where allowed by AS1170.4 - 2007)	250mm	50mm
Unrestrained component to restrained component	150mm	50mm
Restrained component to restrained component	50mm	50mm
Penetration through structure such as walls or floor	50mm	50mm
Unrestrained services passing through the ceiling	25mm	25mm
Sprinkler heads with flexible droppers	nil	nil
Note: Ceiling hangers and braces are considered to be restrained components for the purpose of this table, hence 150mm horizontal clearance is required between ceiling hangers and unrestrained services.		

Figure 2: Guide to the Minimum Clearances – Extract form NZS 4219

1.5 Fire Services

1.5.1 Fire Sprinklers

Supports

- Pipe supports must be located so they do not obstruct the distribution of water from any sprinkler head.
- Range pipes exceeding 500mm in length in accordance with *Clause 2.7 of AS2118.9* must have:
    - At least 1 support, and if longer at not more than 2m from the riser dropper or distribution pipes.
    - A distance from the last support to the end of a range pipe not exceeding:
        - <25 mm nominal diameter - 1.0m
        - >25 mm nominal diameter - 1.5m

Figure 1: Range pipes supports over 500mm in length

- Distribution pipes in accordance with *Clause 2.7 of AS2118.9* must have:
    - Support within 1m from the end and not more than 2m from the main distribution pipe.
    - A distance from the last support to the end of any distribution pipe not exceeding 1m.

Figure 2: Distribution pipe supports

- Distribution pipes in accordance with *Clause 2.7 of AS2118.9* must have:
    - A support located not further than 1m from any change of direction.
- Main vertical pipes rising (or dropping) from the installation valves, or linking the piping between levels, in accordance with *Clause 2.7 of AS2118.9* must be:
    - Supported directly from the structure.
    - Supported on horizontal branch piping from the riser not more than 300mm from the riser.
- Pipes must be supported in accordance with spacing in *Table 2.6.1 of AS 2118.9* (outlined in horizontal pipe support spacing).

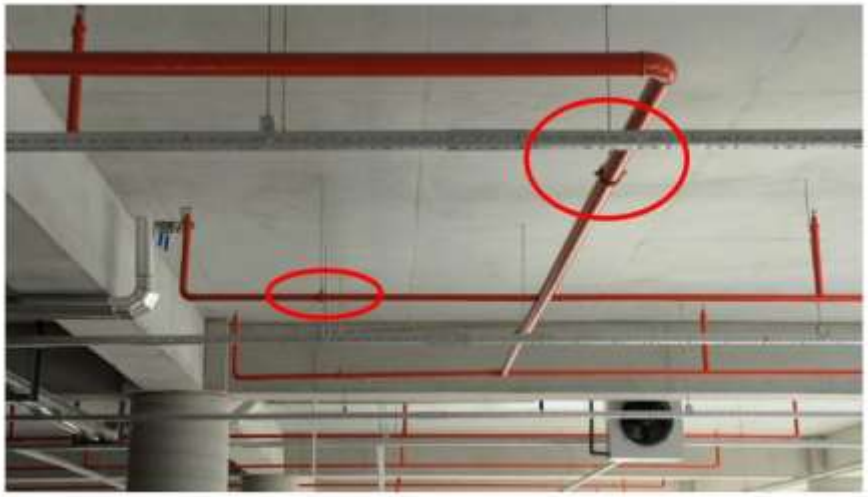


Figure 3: Distribution pipes supports at bends

Testing

- Fire sprinklers must be tested in accordance with *Clause 7.9 pf AS 2118.1* by undertaking a:
  - Hydrostatic test pressure of 1600 kPa, or 400 kPa in excess of the maximum static working pressure (whichever is the greater) for a period of 2 hours.
  - Pneumatic pressure tests of 300kPa for period of 30 minutes with no more than 10% loss of the starting pressure, with a 10 min temperature normalising period prior to the starting pressure reading.

Protection

- Sprinkler heads must be protected with guards in areas where sprinkler heads may be knocked.

Seismic

- Seismic restraints/bracing in accordance with AS1170.4 - 2007 must be:
  - Detailed and installed as per approved shop drawings.
  - Installed for the following fire services:
    - Fire and smoke detection systems
    - Fire suppression systems (including sprinklers)
    - Life safety system components
    - Suspended reticulated services 65mm in diameter above, installed 300mm or lower below the fixed point to the structure.
- Separation between restrained and unrestrained services must be in accordance with the table below.

Condition being considered	Minimum clearance	
	Horizontal	Vertical
Unrestrained component to unrestrained component (where allowed by AS1170.4 - 2007)	250mm	50mm
Unrestrained component to restrained component	150mm	50mm
Restrained component to restrained component	50mm	50mm
Penetration through structure such as walls or floor	50mm	50mm
Unrestrained services passing through the ceiling	25mm	25mm
Sprinkler heads with flexible droppers	nil	nil
Note: Ceiling hangers and braces are considered to be restrained components for the purpose of this table, hence 150mm horizontal clearance is required between ceiling hangers and unrestrained services.		

Figure 4: Guide to the Minimum Clearances – Extract form NZS 4219

1.5.2 Hydrants

Materials

- Materials used in fire service installations must be:
    - In accordance with AS/NZS 3500.1 and AS 2419.1
    - As per approved sample with plastic pipes not specified for above ground use.
- Galvanized steel fire hydrant or booster riser pipes, fittings and couplings in accordance with *Clause 9 of AS2419.1* must:
    - Only be used below ground for individual hydrant risers or short connection pieces not exceeding 1.5m in length.
    - Be double wrapped with a petrolatum tape for the entire length.
    - Be “heavy” gauge with pipe sizes DN80 or less and may be “medium” gauge for DN100 and larger.
    - Be marked with the thickness

Figure 5: A hydrant riser connected to a plastic main

Features, Accessibility and Clearances

Fire hydrants in accordance with Clause 3.2 of AS2419.1 must:

- Have the centre-line of the fire hydrant valve or outlet not less than 750mm and not more than 1200mm above the ground, floor or platform.
- Contain the requirements of Figure 7
- Have the fire hydrant valve outlet horizontal or sloping not more than 35 degrees below the horizontal
- Have a 65mm nominal diameter hose connection
- Be equipped with protective caps and secured
- Be identifiable by a disc of not less than 20mm diameter displaying the fire hydrant no.
- Clearance of not less than 1m directly in front of the fire hydrant.
- Clear space extending to not less than 500mm either side of the fire hydrant riser where the fire hydrant is classified as an external fire hydrant.
- Clearance of not less than 100mm around the handwheel of the fire hydrant valve, in both the fully closed and fully open positions.
- Clearance around the fire hydrant valve outlet of not less than 300mm through an arc of 225° in the plane of the valve outlet.

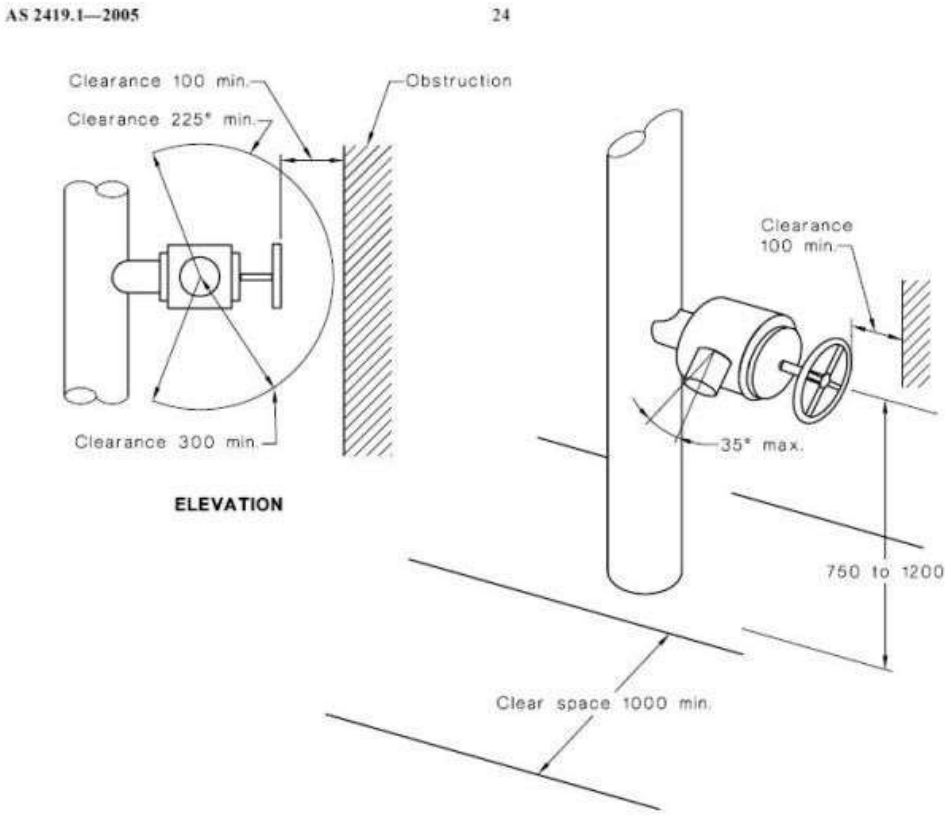


Figure 6: Fire hydrants – internal – clearances – Extract from AS2419.1

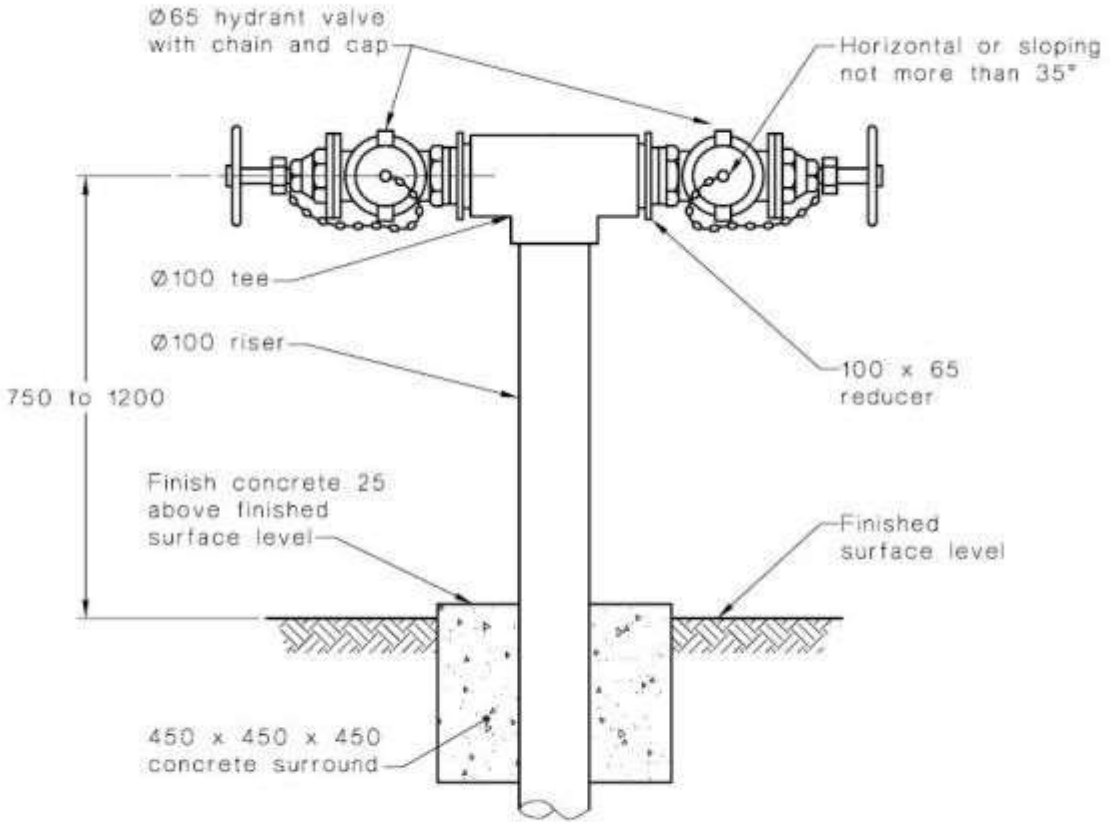


FIGURE 3.2.2.1 EXAMPLE OF AN EXTERNAL FIRE HYDRANT

Figure 7: Example of an External Fire Hydrant

Above Ground Isolation Valves

- Must:
- Be installed within fire isolated exits only, or fire plant, tank and pump rooms as per AS2419.1 Clause 8.7
- Have an identification number that corresponds with the number shown on the block plan referencing the same clause.
- Be full-flow outside screw and yoke wheel gate valves of the indicating type, or low torque wheel-operated multi-turn post indicator ball or butterfly valves with all metal actuating mechanisms, closed by rotating the wheel clockwise and must:
    - be secured or locked in the open position.
    - have affixed to the valve body or strap, a plate inscribed with the words 'FIRE MAIN VALVE – SECURE OPEN' in uppercase letters not less than 8 mm high.
- Leaver type butterfly valves cannot be used on a fire hydrant system or any pipework between the fire hydrant system and the water supply it is connected to, specifically the backflow prevention device at the property boundry.

Figure 8: Lever type butter fly valve (Non-Compliant when used on fire services)

Testing

- Fire hydrants for buildings not more than 50m in height must be tested in accordance with *Clause 12 of AS 2419.1* at 1700 kPa for two hour duration.
- Fire hose reels must be tested in accordance with *AS 3500.1* at 1500 kPa for 30 minutes.

1.5.3 Fire Control Room/ Centre

- Fire Control Centre:
  - Must be provided in buildings 25m high.
  - Can be located in the buildings reception area or lobby, in full view or in a cupboard that is clearly signed as the Fire Control Centre.
  - Is required to have:
    - All alarm panels, fire fan controls and evacuation system.
    - Colour-coded, durable, tactical fire plans.
- Fire Control Room:
  - Must be provided in buildings 50m or more in height.
  - Is required to have:
    - Two hour fire rated room
    - Direct level access from the street
    - Acoustic separation from the fire valve/pump room
    - All alarm panels, fire fan controls and evacuation system
    - Separate pressurisation/ventilation system
    - Emergency lighting
    - Direct phone line
    - A blackboard or whiteboard
    - A pin board
    - A raked plan layout table
- Colour-coded, durable, tactical fire plans.

1.6 Medical Gas

Brackets and Clips

- Horizontal and vertical pipework must be mounted in accordance with *Table 4.1 of AS2896*. (horizontal pipe and vertical pipe support spacing).
- Pipe supports must:
  - Prevent sagging or distortion of the system.
  - Be mounted on brackets separate to other pipe system.
  - Be suitable for medical gas pipelines and not utilise U bolt pipe clamps.

Pipework

- Pipework arriving on site with the caps missing must be rejected as unsuitable for use on medical gas systems and should be returned to the supplier for replacement.

Figure 1: Pipework with caps

Labelling

- Medical pipe lines in accordance with *Clause 3.6 of AS 2896* must have pipe labelling:
    - During the installation process.
    - Wrapped completely around the correct tube and the incorrect arrow direction of flow removed.
    - Every 6m or direction of work and either side of fire, smoke and acoustic walls where the service cannot be seen.

Testing

- Witness the pressure tests after installation of terminal units (but before the wall is closed in) on each section of the piping system.

System	KPA	Period
Medical gas (oxygen, nitrous oxide, medical air	620 kPa	4h
Surgical tool air	1800 kPa	4h
Vacuum	40 kPa	4h

1.7 Lifts

Lift Shafts

- Builders works items to be addressed prior to and after handing over a lift shaft to the Lift Subcontractor must include:

Lift shafts and pits are:

- Constructed as per layout drawings.
- True and plumb within the tolerances specified.

Lift pits are:

- Fully tanked and provided with a dry sump.

Walls of the lift shafts have been:

- Inspected by the lift subcontractor prior to pour.
- All necessary openings, rebates and chases for doors, emergency exits, call station boxes, indicators and supervisory panels as indicated and dimensioned on the approved lift layout drawings.
- Be true and plumb to within the tolerances specified.

Set downs as dimensioned on lift layout drawings must be:

- Provided in the floor slab at the bottom of each door opening for doorsills from the FFL (finished floor level) of each landing.

Horizontal datum for door sills adjacent must be:

- Provided to doorway openings at each level to enable installation of doorjambs.

1.8 Plant Rooms

Hobs

- Hobs in plant rooms must be:
    - Installed for every penetration
    - Installed at each riser on each floor behind the riser cupboard door
    - Membraned and sealed
    - At a minimum 100mm in height.

Acoustic

- Refer to the site specific acoustic specification.

Seismic

- Seismic restraints/bracing in accordance with AS1170.4 - 2007 must be:
    - Detailed and installed as per approved shop drawings
    - Installed for the following mechanical services:
        - Smoke control systems
        - Ducts and pipework
        - Suspended reticulated services 65mm in diameter and above and gas services 25mm and above, installed 300mm or lower below the fixed point to the structure.
- Seismic restraints/bracing do not need to be installed on:
    - Piping in boiler and mechanical rooms with less than 32mm inside diameter
    - All other piping with less than 64mm inside diameter

- All electrical conduit with less than 64mm inside diameter
- All rectangular air-handling ducts with less than 0.4m2 in cross sectional area
- All round air handling ducts less than 700mm in diameter.
- All ducts and piping suspended by individual hangers 300mm or less in length from the top of the pipe to the bottom of the support for the hanger.

- Separation between restrained and unrestrained services must be in accordance with the table below:

Figure 1: 4 way restraint using wire rope & acoustic spring isolator mounts

Condition being considered	Minimum clearance	
	Horizontal	Vertical
Unrestrained component to unrestrained component (where allowed by AS1170.4 - 2007)	250mm	50mm
Unrestrained component to restrained component	150mm	50mm
Restrained component to restrained component	50mm	50mm
Penetration through structure such as walls or floor	50mm	50mm
Unrestrained services passing through the ceiling	25mm	25mm
Sprinkler heads with flexible droppers	nil	nil
Note: Ceiling hangers and braces are considered to be restrained components for the purpose of this table, hence 150mm horizontal clearance is required between ceiling hangers and unrestrained services.		

Figure 2: Guide to the Minimum Clearances – Extract form NZS 4219

Fire Dampers

Refer to section Fire Dampers under the Chapter 'Services_Mechanical'.

1.9 Commissioning and Handover

Building works items that need to be completed in some cases several months ahead of PC to enable the commissioning and handover of the building include:

- Plant rooms and plant areas completed.
- Façade complete and air tight.
- Building air shafts complete and air tight.
- Fire and smoke compartments sealed which includes façade, walls (full height), doors and hardware installed.
- Doors with access control to have all hardware installed.
- Fire stairs complete including doors, hardware and closers installed.
- Fire control room and fire pump room complete and clean.
- Boundary Trap Rooms/ Gas Meter Rooms/ Hydraulic Pump rooms painted, clean.
- Electrical rooms and cupboards clean and lockable.
- Communications rooms /cupboards painted, clean and lockable.
- BMCS room /cupboards painted, clean and lockable.
- Lights installed to test lighting control.
- Ceiling and all flooring (majority) installed to check lux levels (normal lights and emergency lights).

1.10 Below Ground Seperation Distances (in mm)

		Water Service (drinking water supply)			Under - ground sanitary drain	Stormwater drain not greater than DN100	Stormwater drain greater than DN100	Electrical supply cable	Consumer gas pipe	
		Cold Water								
		Not greater than DN65	Greater than DN65	Heated Water						
Non-drinking water		300	300	300	100	100	300	100 for </= DN 65 or 300 for > DN65	100 for </= DN 65 or 300 for > DN65	
Consumer Gas	Indicated with orange marker tape laid 150mm above the installed pipe and mechanically protected.	100	300	100	100	100	100	100	N/A	
	Neither indication nor mechanically protected	600	600	600	600	600	600	300	N/A	
Electrical Supply	Indicated with orange marker tape laid 150mm above the installed pipe and mechanically protected.	100	300	100	100	100	100	100	N/A	
	Neither indication nor mechanically protected	600	600	600	600	600	600	N/A	300	
Sanitary drain		100	100	100	100	100	300	N/A	N/A	100
Electrical earthing rod for electrical supply not exceeding 1000V		500	500	500	500	600	600	N/A	500	N/A
Communication cable		100	100	100	100	100	100	N/A	N/A	N/A

Figure 1: Below Ground Separation Distances

1.11 Above Ground Seperation Distances (in mm)

	Water Service (drinking water supply)			Storm-water pipes (down-pipes)	LV electrical supply cable (not exceeding 1000V)	Consumer as pipe	Communication cable
	Cold Water		Heated Water				
	Not greater than DN65	Greater than DN65					
Non-drinking water (not installed in PPE duct or structurally separated)	100	100	100	100	25	25	50
Consumer gas pipe	25	25	100	100	25	N/A	150
Electrical supply cable	25	25	100	100	N/A	25	50
Sanitary drain (drainage pipe)	100	100	100	N/A	100	100	100
Communication cable	50	50	150	100	50	150	N/A

Figure 2: Above Ground Services Separation Distances

1.12 Horizontal Pipe Support Spacing (meters)

Nominal Size	PVC-U	PVC-U	Copper or light wall steel	Gal steel	Copper	Copper	PVC-U, CPVC, PE	Copper	PVC-U	Steel	Steel	Copper	Steel	Copper	Fuel Gas	
	Water – Pressure	Liquid – non-pressure	Sprinkler Water		Medgas	Storm Water		Sanitary Water		Water	Steam, gas or air	Water				
	AS 2032 Table 6.2	AS 2032 Table 6.3	AS 2118.9 Table 2.6.1		AS 2896 Table 4.1	AS 3500.1 Table 5.6.4		AS 3500.2 Table 10.2.1		AS4041 Table 3.28.2		AS 4809 Table 6.2			AS 5601.1 Table 4.2	
10	0.5					1.5	0.5					1.5	2.0		1.5	
15	0.6				1.5	1.5	0.6					1.5	2.0		1.5	
18						1.5	0.6					1.5			1.5	
20	0.7		1.5	4.0	1.8	1.5	0.7			2.0	3.0	1.5	2.5		1.5	
25	0.75		2.0	4.0	2.0	2.0	0.75			2.4	3.3	2.0	2.5		2.0	
32	0.85	0.9	2.5	5.0	2.0	2.5	0.85			2.7	3.7	2.5	3.0		2.5	
40	0.9	1.0	2.5	5.0	2.5	2.5	0.9	3.0	1.0	3.0	4.0	2.5	3.0		2.5	
50	1.05	1.0	3.0	5.0	2.5	3.0	1.05	3.0	1.0	3.4	4.5	3.0	3.0		3.0	
65	1.2	1.2	3.0	5.0	2.5	3.0	1.2	3.0	1.2	3.7	5.0	3.0	3.0		3.0	
80	1.35	1.2	4.0	5.0	3.0	3.0	1.35	3.0	1.2	3.9	5.1	3.0	4.0		4.0	
90		1.2	4.0	5.0	3.0	3.0	1.4	3.0	1.2			3.0				
100	1.5	1.2	4.0	5.0	4.0	3.0	1.5	3.0	1.2	4.3	5.2	3.0	4.0		4.0	
125	1.7	1.2	4.0	6.0		3.0	1.7	3.0	1.2			3.0	4.0		4.0	
150	2.0	1.2	4.0	6.0		3.0	2.0	3.0	1.2	5.2	6.5	3.0	4.0		4.0	
200	2.3	1.5								6.0	7.5	3.0	4.0		4.0	
500	3.0	1.5								10.0	13.0					

Figure 3: Horizontal Pipe Support Spacing

1.13 Vertical Pipe Support Spacing (meters)

Nominal Size	PVC-U	PVC-U	Copper	PVC-U, CPVC, PE	Copper	PVC-U
	Water – Pressure	Liquid – non-pressure	Medgas	Stormwater	Sanitary Water	Sanitary Water
10	1.0			1.0	3.0	
15	1.2		1.8	1.2	3.0	
18				1.2	3.0	
20	1.4		2.0	1.4	3.0	
25	1.5		2.5	1.5	3.0	
32	1.7	1.8	2.5	1.7	3.0	
40	1.8	2.0	3.0	1.8	3.0	2.0
50	2.1	2.0	3.0	2.1	3.0	2.0
65	2.4	2.5	3.5	2.4	3.0	2.5
80	2.7	2.5	3.5	2.7	3.0	2.5
90		2.5		2.8	3.0	2.5
100	3.0	2.5	4.0	3.0	3.0	2.5
125	3.4	2.5		3.0	3.0	2.5
150	4.0	2.5	4.0	4.0	3.0	2.5
200	4.6	3.0	4.0		3.0	3.0
250	5.2	3.0	4.0		3.0	3.0
>250	6.0	3.0			3.0	3.0
	AS 2032 Table 6.2	AS 2032 Table 6.3	AS 2896 Table 4.1	AS 3500.1 Table 5.6.4	AS 3500.2 Table 10.2.1	

Figure 4: Vertical Pipe Support Spacing