Part 9 – Services

9.1 General

Service supplies and installations should be designed by an Expert.

Service installations should be designed according to the methods and data published by the Chartered Institution of Building Services Engineers.

Building elements supporting service installations (walls, floors, ceilings and the like) should be specifically designed to carry any supported service appliance or equipment.

Full account should also be taken of the added mass of water contained in the appliances and equipment during their normal use. This is particularly applicable to cold water storage cisterns, hot water storage cylinders and boilers.

Gas and water services should not generally be run in timber frame external wall panels unless the design specifically allows for this.

PRECAUTIONS AGAINST FROST, ENTRY OF GAS AND VERMIN

All water services, including those for space heating, should comply with BS 6700:2006+A1:2009. Any part of a water pipe or appliance liable to freezing should be located within the heated thermal envelope of the building.

Where pipes, ducts or cables pass through the building envelope, holes and floor perimeters should be sealed and made watertight with a flexible, vermin-proof and gas-tight compound (see diagram 9.1).

APPLIANCES – SAFETY AND LOCATION

Exposed surfaces of accessible appliances should have no sharp edges which could cause injury to persons.

All appliances and components which are heated in normal operation should be located so that movement and shrinkage of structural and other timber is minimized.

Flue outlets to gas and oil appliances should be protected with a suitable guard where people can come into contact with them, or where they could be subject to damage e.g. vehicular access. Balanced flue outlets should be located a minimum of 300mm or 600mm (depending on fuel) away from any opening into the dwelling, including roof voids. In certain circumstances a minimum of 1200mm is required. For further details refer to Approved Document J (Technical Standards for Scotland: Part F).

Diagram 9.1: Sealing of service entry points
# SELECTION OF APPLIANCES AND EQUIPMENT

Materials and equipment should, wherever possible, either bear the British Standard 'Kitemark' symbol and be manufactured by firms registered under the BSI 'Kitemark' scheme, or should comply with the relevant British Standard and be manufactured by a firm operating a BS EN ISO 9001-9004 Quality Assurance System which is regularly assessed by a recognised independent Third Party.

Materials should be selected so that corrosive deterioration is minimised. If different metals are used in combination, particularly in humid locations, they should be chosen to be as near as possible in the electro-chemical series of metals so that galvanic action is unlikely to occur (i.e. not more than two metals apart in the list). Some typical metals in the order they appear in the series are:

- Stainless steel
- Copper/Cupro-nickel
- Brass/Gunmetal
- Steel
- Aluminium
- Galvanised iron
- Zinc

If metals remote from each other in the series have to be used, adequate precautions should be taken to prevent their corrosive interaction.

All materials and equipment should be installed and commissioned as specified by the manufacturer.

Appliances and equipment should be selected so that they are suitable for the designed thermal loads, fluid flow rates and fluid pressures.

## INSTALLATION OF PIPES, DUCTS AND CABLES

- Pipes, ducts and cables should be securely fixed to walls within floor zones etc. at suitable intervals to prevent sagging, using purpose made proprietary support brackets or clips.
- All joints in pipework should be carefully made to eliminate leaks.
- Pipes should be laid to falls away from high points in the installation to aid being drained and provision made for air venting at the high points where required.
- Pipework should be arranged to prevent contact with electric cables.
- Provision should be made for expansion of water service installations where required.
- Pipework and cables should have a neat appearance where visible, with all bends being neatly made using the correct tools.
- Appliances shall be installed level unless specifically designed otherwise, using durable fixings.
- Installation of electrical cables and gas pipework should be undertaken by a competent person as specified in the Building Regulations. Build-Zone normally defines a “competent person” as a fully qualified tradesman registered by NICEIC - National Inspection Council for Electrical Installation & Contracting / GASSAFE Registered Gas Installers.
- Gas pipework in the proximity of electrical cables should follow the GASSAFE requirement guidance.

### Services Embedded in Floors and Walls and Positioned Beneath Floor Slabs

Service pipes and cables should not be laid within a structural element unless approved by the designer of the building. Where permitted, they should not be solidly embedded.

Service pipes and cables should be sleeved, isolated and sealed when passing through a structural element. Where passing through joists, it is recommended that hessian or similar is provided to prevent expansion noise.

Pipes should not be cast into walls and floors, the use of a proprietary accessible ducting system being strongly recommended (see diagram 9.2). Pipes behind dry lining should be placed either horizontally below the valves, vertically within the radiator width from ceiling to floor level or within 150mm of a wall junction or a door frame. If located outside these zones, then mechanical protection should be provided.

Appliances should be located and positioned so as to allow reasonable access for operation, inspection, maintenance and removal.

In order to avoid subsequent damage during the laying of floor coverings, it is recommended that principal pipework runs in screeds are not located within 200mm of walls and should pass through door openings at the centre line (see diagram 9.2).

Only pipework forming part of a closed circuit system of under floor space heating or above ground central heating may be laid in floor screeds and should be laid as follows:
9.1 General

- A clear minimum thickness of screed of 25mm is required over and above the thickness of any pipework buried in the screed or insulation.
- Where the screed is to be laid upon insulation, the required nominal reinforcement to the screed should be continuous over the pipework. D49 or D98 mesh reinforcement should also be provided over multiple pipes laid together in normal screeds.
- Allowances for thermal and other types of movement must be made.
- Pipes bedded in screeds should be tested to twice the designed operating pressure of the system and joined with the minimum number of capillary joints.
- It is advisable to check that pipes bedded in screeds will meet the requirements of the local supply company.

Conduits and ducts should be located in such a manner as to allow reasonable access for inspection and maintenance without major disruption to the structure.

Flexible connections should be provided to services, conduits and ducts at their entry point into the structure. Raft foundation design details should show such service arrangements in relation to the reinforcement details. Warm air ducts below ground floors should be constructed and positioned to avoid ingress of moisture into the duct or surrounding insulation. Warm air ducts located beneath the ground floor of a dwelling which sits on clay soil should be positioned and insulated so as to prevent heat drying the clay, which may cause subsidence of the structure.

Services in Walls

When installing services e.g. cables in walls or behind dry lining, care should be taken to avoid back to back chasing which could affect the stability of the wall (see diagram 9.3).
9.1 General

**ISOLATION, DRAINING DOWN AND MAINTENANCE OF SERVICE INSTALLATIONS**

Installations designed to hold water should be capable of being drained. Drain cocks, or similar, should be located at the lowest point of the system. In some circumstances there may be short lengths of pipe at low level, such as when passing under a door, that may not be practical to drain. However if a substantial amount of pipework is run in a screed then arrangements should be made for complete drainage (see diagram 9.4). Wet systems serving more than one dwelling should be capable of being drained down separately.

Isolation valves and switches should be provided to services serving separate dwellings within the same building and should be accessible and clearly identified.

**TELEPHONE**

A conduit should be provided from the telephone position to the communications company's duct or overhead terminal. A draw wire should be left in the conduit.

The conduit entry from outside to inside the building should be sealed to prevent moisture ingress.

**TELEVISION**

A single, unbroken length of cable suitable for frequencies currently in use for television should be provided between an aerial point in the loft and a co-axial socket outlet in the main living room. A ‘tail’ of approximately 4m should be left in the loft. The cable from the loft to the living room should be installed to comply with BS EN 60728-1-1:2010.

**FIRE-STOPPING**

Fire-stopping should be provided around any services which penetrate fire-resisting floors, walls or partitions. Where a proprietary system, such as an intumescent seal, is used it should be installed in accordance with the manufacturer’s instructions.


9.2 Electrical Installations

Electrical installations will be subject to the requirements of Approved Document P Electrical Safety and should comply with the Wiring Regulations of the Institute of Electrical Engineers (IEE) and BS 7671: 2008.

Part P applies to electrical installations in buildings or parts of buildings comprising:

- Dwelling houses and flats
- Dwellings and business premises where there is a common supply
- Common access areas in blocks of flats such as corridors and staircases
- Shared amenities of blocks of flats such as laundries and gymnasiums.

Part P also applies to parts of the above electrical installations:

- In or on land associated with the buildings - for example fixed lighting and pond pumps in gardens
- In outbuildings such as sheds, detached garages and greenhouses
- Where there is a relevant material change of use.

CERTIFICATION

The installation should be designed and installed to provide appropriate protection against mechanical damage, and so that it does not present electric shock and fire hazards to people.

The installation must be suitably inspected and tested to verify that it meets the relevant equipment and installation standards. A way of demonstrating this compliance would be to follow the procedures in Chapter 74 of BS 7671 2008 and to supply:

- To the person ordering the work, copies of the forms called for, signed by a person competent to do so, and
- In the case of a competent person registered with an electrical self-certification scheme, to the building control body a declaration that compliance with the Building Regulations has been achieved.
- To Build-Zone at final completion, a certificate showing compliance with Part P.

To be able to complete the relevant forms it is necessary to ensure that work has been inspected both during erection and on completion. The work must comply with the appropriate British Standards or harmonised European Standards, be selected and installed in accordance with BS 7671 and not be visibly damaged or defective so as to be unsafe.

Testing must include confirmation that there is a satisfactory performance in relation to continuity of conductors, insulation resistance, separation of circuits, polarity, earthing and bonding arrangements, earth fault loop impedance and functionality of all protective devices including residual current devices.

The inspection and testing of DIY work/installations should meet the same requirements.

Electrical installations should be fitted by an installer registered with the National Inspection Council for Electrical Installation and Contracting (NICEIC) or the Electrical Contractors Association (ECA).

ELECTRICAL DESIGN

Power systems should comprise ring main circuits in preference to radial circuits.

<table>
<thead>
<tr>
<th>Location and socket outlet</th>
<th>Living room 6-10</th>
<th>Dining Room 3</th>
<th>Double Bedroom 4-6</th>
<th>Single Bedroom 4-6</th>
<th>Hall 1</th>
<th>Kitchen 6-10</th>
<th>Study 6</th>
<th>Loft 1</th>
<th>Home office 6</th>
<th>Utility 2</th>
<th>Stairs/landing 1</th>
<th>Garage 2</th>
</tr>
</thead>
</table>

The table is for guidance and is subject to the size and type of property.

Table 9.5: Guidance for provision of socket outlets

Table 9.5 provides guidance on the minimum number of socket outlets that should be provided in a dwelling. However this is subject to the size and type of property.

Socket outlets should be conveniently situated and evenly distributed around each room.

It is suggested that in kitchens and utility rooms, socket outlets should also be provided adjacent to any spaces specifically reserved for appliances such as refrigerators, dishwashers and washing machines.
Accessible consumer units should be fitted with a child-proof cover or installed in a lockable cupboard. A cooker control unit should be provided in kitchens adjacent to the cooker position.

Socket outlets should be conveniently positioned, close to television aerial and telephone outlets to allow for associated ancillary equipment such as answering machines, TVs and videos.

At least one fixed electric light fitting should be provided to kitchens, utility rooms, halls, landings and entrances respectively. All other rooms should be provided with either:

- One fixed light to rooms less than 25 m² and two fixed lights for areas greater than 25 m² or
- Additional socket outlets, corresponding to the number of fixed lights required.

Lights on stairways should be controlled with two-way switches.

Immersion heater switches should be located in a prominent position and provided with an indicator light.

Cables located adjacent to thermal insulation should be de-rated accordingly.

It is important to assist people whose reach is limited and to enable them to use wall mounted switches and socket outlets more easily. Switches and socket outlets for lighting and other equipment should be positioned at appropriate heights between 450 mm and 1200 mm from finished floor level.

**Examples of Electrical Installations Diagrams**

The following simplified diagrams do not give all the information required to achieve compliance with BS 7671, nor do they cover all the electrical services found in dwellings, some of which (e.g. swimming pools and saunas) are subject to special requirements.

The diagrams must not be used for installation purposes.

![Diagram 9.6: Key to diagrams 9.7 – 9.11](image-url)
9.2 Electrical Installations

Diagram 9.7: Illustration of the fixed electrical installation commonly encountered in a new home

EARTHING

For most dwellings where PME is provided, the main equipotential bonding conductor must be at least 10mm\(^2\), see diagram 9.8.

Where no PME is available, the minimum size for the equipotential bonding conductor is at least 4mm\(^2\). It is not permitted to use gas, water or other metal service pipe as a means of earthing for an electrical installation.

This does not preclude equipotential bonding connections to these pipes. The minimum size of the main equipotential bonding connector is 10mm\(^2\). The minimum size of the supplementary equipotential bonding connector is 4mm\(^2\).

Diagram 9.8: Illustration of the earth and bonding conductors that might be part of the electrical installation shown in Diagram 9.7 (indicates earthing and bonding arrangements that may be necessary)
9.2 Electrical Installations

Diagram 9.9: Example earthing arrangement where the electricity distributor provides the earth connection (referred to as TN-C-S where the connection is made to A, or TN-S where the connection is made to B – the most common systems in urban areas). Indicates earthing arrangements that might be provided by electricity distributors.

Diagram 9.10: Illustration of the earthing and bonding conductors that might be part of the electrical installation shown in diagram 9.7

1. See the general rules in BS 7671 : 2001
2. Circuit protective conductors are taken to all items of fixed electrical equipment and local isolation and switches devices which appear in diagram 9.8.
3. In the case of a protective multiple earthing (PME) supply (see diagram 9.9) consult the electricity distributor.
4. Supplementary bonding is required in bathroom to an extent dependent upon the presence of metallic fixtures, fittings and pipework: see selection 601 of BS 7671 : 2001.
Holes in Ceilings

Downlighters and other flush fitting attachments should not be installed through a ceiling if the ceiling is providing part of the required sound insulation or fire resistant properties to the dwelling. An additional suspended ceiling, light box or proprietary fittings must be installed to maintain the integrity of the ceiling construction.

Where downlighters are provided to ceilings below roof voids (excluding thatched roofs) precautions should be taken to ensure that no fire risk is created by the proximity of other materials. This can be achieved by the following:

- Using light fittings that produce a maximum temperature of 50°C at the rear of the fitting
- Using downlighters with intumescent and acoustic fittings.

Downlighters should not be used to the ceiling on the underside of a thatched roof.

Energy Efficient Lighting

“Reasonable provision” is required to provide dedicated low energy fittings as follows:

1 for every 25m² floor area created or 1 in every 4 fixed light outlets provided (whichever is greater). These should be provided in the most used rooms i.e. hall/landing, lounge, kitchen, dining room. Use in garages, cloakrooms and cupboards cannot be counted towards the required provision.

Reasonable provision should be made for the use of energy efficient external lighting. External lighting includes porches but not lighting in garages and carports. When providing external lighting install a system which:

- Is max. 150W and automatically extinguishes when there is enough daylight, and when not required at night, or
- Has fittings that will only take lamps of a luminous efficiency of 40 lumens per circuit watt.

Selection of Materials and Equipment

All components, equipment and appliances should be constructed in accordance with BS EN 60335-1:1994+A2:2000.

For additional guidance for locations containing bathrooms and showers, see BS 7671, which has a series of classification zones relating to locations containing baths and/or showers. They are as follows:

- Zone 0 – the interior of the bath or shower
- Zone 1 – above zone 0 to a height of 2.25m above the floor
- Zone 2 – ‘wraps’ around zones 0 and 1 for a horizontal distance of 0.6 m
- Zone 3 – ‘wraps’ around zone 2 for a further horizontal distance of 2.4 m.
The above zones affect the safe installation, method and location of:

- Supplementary bonding
- Protective measures against electric shock
- Wiring methods i.e. surface and embedded wiring
- Switchgear and control gear
- Fixed current using equipment, including amongst others pumps, heaters, lights and extractor fans.

Further detailed guidance can be found in BS 7671.

It is further recommended that sockets and switches outside those rooms containing a bath or shower but nevertheless still prone to splashing, should be positioned a minimum of 300 mm from the water source e.g. kitchen sinks and cloakroom basins.

It is not permitted to use a gas, water or other metal service pipe as a means of the main earthing for an electrical installation. This does not preclude equipotential bonding connections to these pipes.

Main equipotential bonding conductors are required to connect to the main earthing terminal for the installation in the following:

- Metal water service pipe
- Metal gas installation pipes
- Other metal service pipes and ducting
- Metal central heating and air conditioning systems
- Exposed metal structural parts of the building
- Lightning protection systems

NB if the incoming service pipe is plastic it is not necessary for this to be main earth bonded. However if the pipes within the plumbing installation are metal then main earth bonding is required. The bonding should be applied to the consumer side of any meter, main stopcock or insulating insert and to the metal pipes of the installation. If the incoming services are a mix of plastic and metal then the metal pipes must be main bonded.

The connections of the bonded pipes must be made with a propriety clamp to BS951 and be complete with a label: “SAFETY ELECTRICAL CONNECTION-DO NOT REMOVE”.

Typical earthing arrangements and protective conductor csa-TN-C-S is shown in Diagram 9.9 (indicates earthing and bonding arrangements that maybe necessary).

**Supplementary Earth Bonding**

For domestic situations supplementary bonding is required in areas of increased risk. These are rooms containing a bath or shower. Supplementary bonding in kitchens, utility rooms or wash rooms is desirable but not mandatory, see diagrams 9.12 – 9.13.

Where plastic pipes are used within a bathroom or shower room, supplementary bonding is not required to the pipes or the metal fitments attached to them. Where short lengths of metal pipes connected to bathroom fittings are attached to plastic pipes (a common practice to provide a more aesthetic finish) these also do not require supplementary bonding.

Supplementary bonding is still required to electrical equipment for example an electric shower or electric heater. Such bonding is also required to be connected to the protective conductor of all circuits supplying electrical equipment in the bathroom e.g. at a flex outlet or switch.
Diagram 9.12: Supplementary bonding in a bathroom - metal pipe installation

Diagram 9.13: Supplementary bonding in a bathroom - plastic pipe installation
Most electricians are more generally aware of these requirements and the diagrammatic guidance given in the IEE On-site Guide is reproduced here (see diagram 9.14).

Diagram 9.14: Heights of wiring accessories

ELECTRICITY SUPPLY

The position chosen for the electricity supply intake should be accessible.

If the local supplier service cut-out and meter are located inside the dwelling, then the main cable entry should normally be via a sleeve having a slow bend (see diagram 9.1).

External meter boxes should be of a type approved by the supply authority and located as close as practicable to the main access point to the dwelling.

The installer should provide tails (3m maximum) of sufficient length on the incoming side of the CCU (Customer’s Consumer Unit) for connection to the Electricity Board’s meter.

The supply from an external meter to the CCU may be via a duct through the wall. In such cases the CCU should be located inside the building adjacent to the external meter cupboard.

The earth connection of the CCU should be connected to the sheath of the supply cable or to a separate earth electrode if the Electricity Authority does not provide an earth.

Generally, cables should be located within the shaded zones shown in diagram 9.15.

The final cable run to switches and socket outlets should be vertical or horizontal.

Cables located outside these areas must be enclosed in an earthed metallic conduit or sheath. Wherever possible, horizontal cable runs should be located in floor voids.

Cables located within 50mm of the top or bottom of floor/ceiling joists or battens supporting plasterboard must be contained in an earthed metal conduit.
Earth Bonding

The earth conductor should be not less than 6mm² connected from the consumer unit (earth bar) via suitable bonding clips to the service entry of the incoming water main, gas main and oil supply if provided. In all cases the earth strapping should be located as close to the inlet into the dwelling as possible.

Consumer Unit

The main consumer unit for the electrical installation should be protected by a residual current device (RCD) in order to satisfy the IEE requirements regarding external appliances. All circuits on the consumer board should be clearly marked.

Wiring to Fittings

No unprotected wires should be left within a void. All connections must be made within a protected environment e.g. a junction box or as found on ceiling and wall mounted smoke detectors a pattress box which is mounted directly beneath the detector (ceiling side), to allow all wiring connections to be made on the room side of the ceiling i.e. preventing unprotected wiring connections being pushed up into the floor/ceiling void.

All metal light fittings should be earthed, and ideally the neutral wire from the switch to the light fitting or junction box should be marked with red tape to indicate that this is actually a live wire in this instance.

Party Walls

Wherever possible avoid placing electrical fittings in separating Party Walls. Services in Party walls must be adequately fire stopped and sealed for acoustic performance (see Diagram 9.16). For electrical services in timber frame walls see diagrams 9.17.
Diagram 9.16: Party wall details

Diagram 9.17: Electrical services in timber frame wall
SMOKE DETECTORS

Mains operated self-contained smoke detectors shall be provided in all dwellings.

- There shall be at least one detector on each floor of a dwelling. Where more than one is provided they shall be interconnecting to operate the alarm signal simultaneously in all of them.
- There shall be a smoke detector in the circulation space within 7.5 m of the door to every habitable room.
- Where the kitchen area is not separated from the stairway or circulation space by a door, a heat detector must be fitted in the kitchen in addition to the smoke detector fitted in the circulation space.

Self-contained detectors should be permanently wired to a separately fused circuit at the dwelling’s electricity consumer unit. However, where a battery backup device is fitted it is acceptable to connect the separate wiring to the fuseway of any lighting circuit.

A test should always be carried out on completion to ensure that all units are interconnecting and are operational. Where the system is reliant on a battery back up the power should be disconnected during the test.

FLEXIBLE WIRING SYSTEMS

Flexible wiring systems can be used for the provision of electrical services in traditional and for all types of off-site manufactured homes which can be panelised, volumetric or hybrid construction with the benefit of both labour and time reduction on site.

The systems are complete with miniature power connectors facilitating easy upgrade. A typical system will comprise of:

- Consumer unit
- Power circuit, tee connectors and socket outlets and connection units with flying leads
- Lighting circuit, lighting hub, locking connectors with light switches/fittings with flying leads. (See diagram 9.18).

System Installation

A flexible system should ideally be designed/installed in four phases:

1. **Design**. The system designer converts the architect’s drawings into a detailed proposal for a wiring system to complement the manufacturing techniques of the factory. The system will be designed to the latest edition of the BS7671 17th Edition Wiring Regulations and in accordance with appropriate Building Regulations.
2. **Supply**. The flexible system designer is responsible for supplying comprehensive training, installation instructions and manuals to the building manufacturer. This includes training operatives and training trainers, thus allowing the factory to be self-sufficient to install the flexible wiring systems.
3. **Installation**. Final on-site connections by the customer. An NICEIC trained electrical contractor will then carry out final testing for the installation and supply the NICEIC test certificate.
4. **Handover**. The flexible system supplier will supply every home with a homeowner’s manual; this will include an explanation of the system and a set of drawings of the particular installation.
9.3 Fuels

**GAS SUPPLY**

A meter control valve should be fitted on the supply side of the meter.

External meter boxes should be of a type approved by the supply authority and located as close as practical to the main access point to the dwelling. Gas boxes installed within the external cladding and breaching the cavity must be provided with a cavity tray over and sealed around the perimeter to reduce the possibility of water ingress.

The pipe from an external meter box to the inside of a building should be through a sleeve. After installing the pipe the sleeve should be made water-tight with a mastic sealing material.

When located inside a building, the meter should be installed as near as practicable to the point of entry of the gas service supply pipe into the building.

Gas Safety Regulations require ventilation for ducts at each floor containing gas pipes. Gas pipes may be contained in a separate ventilated duct or they can remain unducted.

For typical balanced flue and gas meter box installation in timber framed buildings (see diagrams 9.20 and 9.21).

**Installation of Service Supplies**

Gas supply systems should be fitted by British Gas or an installer registered with the GasSafe Register (formerly CORGI). Contact 0800 408 5500, www.gassaferegister.co.uk for further information.

**Commissioning and Testing**

Gas installations should be inspected and tested by a competent person before and after the installation of the meter in accordance with the following British Standards and Codes of Practice as appropriate:

- BS 6400 Specification for installation of domestic sized gas meters
- BS 6891 Specification for installation of low pressure gas pipework.

After testing, the gas installation should be purged as detailed in the above-mentioned British Standards and Codes of Practice. After purging is complete the builder should verify that:

- The governor outlet pressure is correct (where appliances are already installed).
- The governor is resealed after any adjustment has been made.
Diagram 9.20: Typical balanced flue detail
Gas Safe Requirements

Where installation pipes are not separated by electrical insulating material, they should be spaced as follows:

a. at least 150mm away from electricity meters and associated excess current controls, electrical switches or sockets, distribution boards or consumer units;

b. at least 25mm away from electricity supply and distribution cables.

Additional requirements

- Behind dry-lined wall: either provide a solid perimeter dab to both sides of the pipe, or chase in, wrap the pipe to protect and mortar over.
- Within timber frame, including timber frame external walls and internal stud walls (timber or metal stud): studs should be provided either side of the pipe and a blocking/infill "stud" behind. The small void created needs to be filled with insulation or equivalent as any duct/space exceeding 0.01m\(^2\) needs to be ventilated.
- BS 6891 2005 allows for gas pipes in intermediate floors as these are considered as voids and voids don’t need ventilating. However, the GAS SAFE Regulations have amended this. Due to changes in construction methods, e.g. glued and screwed floors, sound insulation etc, the previous fortuitous ventilation achieved by gaps in construction is no longer considered to exist. It is, therefore not acceptable to run gas pipes within intermediate floor zones. This applies to Party floors in similar circumstances. As any duct greater than 0.01m\(^2\) needs venting, this would apply to block and beam or similar intermediate floor where the gas pipe is run within the suspended ceiling.

Diagram 9.21: Typical gas meter box detail
9.3 Fuels

**OIL AND SOLID FUEL**

Oil-fired boiler installations should comply with BS 5410:1.

Solid fuel fired installations should comply with BS 8303:1.

Hot water heating systems should be installed by firms which are registered members of the:

- Heating & Ventilating Contractors Association (HVCA), or the
- GAS SAFE REGISTER

**SOLAR**

Solar powered systems should hold independent Third Party accreditation and comply with BS 5918. Solar systems fall outside the cover provided by the Build-Zone Warranty.
COLD WATER SERVICES

System Design

Cold water supply systems should be designed to comply with BS 6700.

Cold water systems may have provision for storage or be directly connected to the main supply. Drinking water should be supplied direct from the main supply.

Cold water pipes and storage cisterns located in roof spaces and other unheated areas should be insulated to BS 6700 and BS 5422.

Distribution pipes should be sized to provide the flow rates at draw-off points as set out in table 9.22.

Draw off points in gravity fed systems should be provided with a minimum 1m head of water measured from the base of the cistern.

Shower installations, where provided, should be designed and installed so that there is no serious rise or drop in the temperature of the water when another water outlet in the dwelling is used. Pipe size design, thermostatically controlled shower units, or a separate cold water supply provided from a header tank can achieve this.

Cold Water Storage Systems

The storage capacity of water cisterns should be as set out in table 9.23.

If it is considered that the water supply may not be regular, a larger capacity cistern should be installed based on a storage of 90 litres per person normally expected to be resident in the dwelling.

<table>
<thead>
<tr>
<th>Location flow rate</th>
<th>(l/s)</th>
<th>Storage type</th>
<th>Capacity (litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bath tap (22mm)</td>
<td>0.3</td>
<td>For cold water storage only</td>
<td>100-150</td>
</tr>
<tr>
<td>Shower</td>
<td>0.1</td>
<td>For cold water storage plus feed to hot water</td>
<td>200-300</td>
</tr>
<tr>
<td>Wash hand basin tap (15mm)</td>
<td>0.15</td>
<td>storage cylinder</td>
<td></td>
</tr>
<tr>
<td>Kitchen sink tap (15mm)</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WC</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9.22: Design flow rates for appliances

Table 9.23: Storage capacity of cisterns

Feed and expansion cisterns for hot water space heating systems should comply with BS 5449.

Storage cisterns should be provided with a full-way gate valve at every outlet other than the header pipe.

All outlet pipes serving cold water draw-off points should be connected to the cistern so that the lowest point of the outlet is at least 30mm above the bottom of the cistern.

Outlet pipes supplying a hot water system should be at least 25mm above cold water draw-off outlets.

An overflow pipe should be provided to all cisterns and be laid to a uniform fall and discharge in a conspicuous place outside the building. It is recommended that overflows are insulated or within the thermal envelope of the building.

Installation

Cold water services should be installed to comply with BS 6700.

Pipes supplying drinking water should not be in close proximity to hot pipes.

After installation, the cistern should be cleaned of all debris and, if galvanized, coated internally with a non-staining, non-toxic, bituminous paint approved by the Water Research Centre.
HOT WATER SERVICES

System Design

Hot water supply systems should generally comply with BS 6700 and be energy efficient.

Gas-fired hot water systems should comply with BS 5546.

Electric water heating installations should comply with BS 6700.

Hot water systems may have provision for storage or may be of the instantaneous type (e.g. combination boilers).

Solar powered systems should comply with BS 5918.

Distribution pipes should generally be sized to provide the flow rates at draw-off points as set out in table 9.24. Certain instantaneous systems may not achieve these flow rates (consult manufacturer) but they can deliver hot water continuously without time to reheat. Where a reduced design flow rate is deemed acceptable, a shower should be provided in addition to any bath to compensate for the reduced flow rate.

Hot water distributing pipes should be as short as practicable and should not exceed the lengths as set out in table 9.25.

Open vented hot water heating systems should be provided with a feed and expansion cistern and separate cold feed and vent pipes to comply with BS 5449.

Expansion vessels used in unvented hot water heating systems should comply with BS 4814. Insulation should be provided to control the heat losses through the safety fittings and pipe work but without impeding safe operation and visibility of warning discharges.

Pumps for circulating hot water should comply with BS EN 1151.

Domestic Hot Water Storage Systems

A storage system should have a storage capacity of not less than 115 litres (200 litres for off-peak heating or in accordance with the electricity authority's recommendations), and should meet the insulation requirements of BS 1566, BS 3198 or BS 7206 (as appropriate).

Hot water should normally be stored at a mean temperature not exceeding 65°C. For normal use 60°C is recommended.

The hot water heating system should be capable of heating the total stored water quantity from cold (10°C) to 60°C in the times as set out in table 9.26.

Boilers and circulators supplying the hot water system should have sufficient heat generating capacity to allow the required recovery times to be achieved when supplying the maximum design space heating load.

<table>
<thead>
<tr>
<th>Location</th>
<th>Flow rate (l/s)</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bath tap</td>
<td>0.3</td>
<td>50</td>
</tr>
<tr>
<td>Sink</td>
<td>0.2</td>
<td>60</td>
</tr>
<tr>
<td>Shower</td>
<td>0.05-0.1</td>
<td>40</td>
</tr>
<tr>
<td>Wash hand basin</td>
<td>0.15</td>
<td>50</td>
</tr>
</tbody>
</table>

The height of any storage cylinder should be such as to achieve these flow rates without excessive size of distribution pipes and fittings. These flow rates should be available to each outlet when only that outlet is open.

Table 9.24: Design flow rates for hot water draw-off points

<table>
<thead>
<tr>
<th>Internal pipe diameter max length *</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 19mm</td>
<td>12.0m</td>
</tr>
<tr>
<td>19-25mm</td>
<td>7.5m</td>
</tr>
<tr>
<td>Over 25mm</td>
<td>3.0m</td>
</tr>
</tbody>
</table>

* Distance from draw-off point to storage vessel (or secondary circulation pipe).

Table 9.25: Maximum lengths of distribution pipes
### System type heat-up period

<table>
<thead>
<tr>
<th>System Type</th>
<th>Heat-up Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas-fired</td>
<td>2.5hrs</td>
</tr>
<tr>
<td>Oil-fired</td>
<td>2.5hrs</td>
</tr>
<tr>
<td>Solid fuel-fired</td>
<td>4.0hrs</td>
</tr>
<tr>
<td>Electric</td>
<td>2.5hrs</td>
</tr>
</tbody>
</table>

**Table 9.26: Domestic hot water heat up period**

### Installation

Pipes distributing domestic hot water from the hot water storage cylinder should be used solely for that purpose.
A stop-valve should be fitted in the secondary cold feed pipe to the hot water storage cylinder.
A drainage tap should be fitted at the lowest point of the secondary cold water feed pipe to allow draining of the stored water. This tap should be suitable for a hose connection.

Hot water storage cylinders should be of the indirect type except where the heating is by electric immersion heater, in which case a direct type cylinder may be used.

Cylinders should be insulated: a factory applied coat of 35mm thick PU-foam having a minimum density 30kg/m³ is normally sufficient.

Where primary circulation is by gravity, the return pipe should be connected to a separate connection on the boiler or into an injector type fitting in the return pipe of the space heating circuit. The hot water storage cylinder should be located at a sufficient height above the boiler to ensure good circulation.

Flow and return pipes between a boiler and a hot water storage cylinder should be used for domestic hot water heating.

Provision should be made to limit the heat loss to pipe work / ducts located outside the fabric insulation as recommended in BS 5422: 2001. Hot pipes connected to hot water storage vessels, including the vent pipe and the primary flow and return to the heat exchanger, where fitted, should be insulated to BS 5422: 2001.

Hot water storage cylinders should always be controlled by a thermostat.

### SPACE HEATING

#### Space Design

Space heating systems should comply as appropriate with the following British Standards and Codes of Practice:

- BS 5410:1/2 Code of practice for oil firing
- BS 5449 Specification for forced circulation hot water central heating systems for domestic premises
- BS 5482:1 Domestic butane and propane gas burning installations
- BS 5864 Specification for installation in domestic premises of gas fired ducted air heaters
- BS 5871:1 Specification for installation of gas fires, convector heaters, fire/back boilers and decorative fuel effect gas appliances
- BS 6700 Specification for design, installation, testing and maintenance of services supplying water for domestic use
- BS 8303 Installation of domestic heating and cooking appliances burning solid mineral fuels

Any whole house heating system should be designed to provide internal temperatures to the levels set out in table 9.27 when the outside temperature is -1°C and using the corresponding air changes per hour. For traditional systems these temperatures may be taken as air temperatures. For non-conventional systems and for all warm-air heating systems they should be considered as dry resultant temperatures.

Open vented hot water heating systems should be provided with a feed and expansion cistern and separate cold feed and vent pipes to comply with BS 5449:1.

Expansion vessels used in unvented hot water heating systems should comply with BS 4814.

Pumps for circulating hot water should comply with BS EN 1151, BS 1394, and BS EN 60335-2-51.

Ducts for warm air heating systems should be sized according to the methods and data published by the Chartered Institution of Building Services Engineers.
9.4 Plumbing/Heating

<table>
<thead>
<tr>
<th>Location</th>
<th>Temperature</th>
<th>Air Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living Room</td>
<td>21°C</td>
<td>1 per hour</td>
</tr>
<tr>
<td>Dining Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitchen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedrooms*</td>
<td></td>
<td>1 per hour</td>
</tr>
<tr>
<td>Bed-sitting rooms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bathrooms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hall &amp; Landing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separate WC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* As the use of a bedroom may be changed to that of a play room or study, or occupied by an elderly person as a bed sitting room, it is recommended that all bedrooms be capable of being heated to 21°C.

** These values are based on natural ventilation. Where mechanical ventilation is used an extra allowance of 50% should be made.

Table 9.27: Space heating requirements

**Controls**

Wet heating systems should be provided with the following controls (see diagram 9.28):

- Zone controls i.e. room thermostats or thermostatic radiator valves.
- Timing controls.
- Boiler control interlocks.

Where thermostatic radiator valves are fitted to radiators, the system should be arranged so that manufacturer's minimum flow rate will continue to flow through the boiler when all valves are closed at the same time.

Ducted warm air systems should be provided with the following controls:

- Room thermostat controlling the heater unit
- Time switch allowing at least two heating periods a day. In the case of electrically heated storage systems, there will normally be a further time switch to control the electrical 'charging' periods to conform with the chosen tariff
- A programmer to select:
  - Hot water
  - Space heating
  - Hot water and space heating

Independent heaters e.g. night storage heaters, should be provided with a thermostat sensitive to the room air temperature (this is often an integral part of the appliance).

**Selection of Appliances and Equipment**

Boilers should be selected for their efficiency, demonstrated by using a boiler with a SEDBUK (Seasonal Efficiency of a Domestic Boiler in the UK) rating not less than the appropriate entry in Table 9.29.

Gas-fired, oil-fired, solid fuel and electric boilers should be type tested by the appropriate Authorities.

Ducted air heater systems should be approved by the Electricity Council's Appliance Testing Laboratory.

Metal ductwork for warm air heating systems should be constructed to comply with the specification for sheet metal ductwork (DW/142) published by the Heating & Ventilating Contractors' Association (HVCA).

Radiators, convectors-radiators and convectors used in the installation should comply with BS 3528.

Forced circulation hot water systems should comply with BS 5449:1.
Diagram 9.28: Controls for combined space heating and domestic hot water installation

<table>
<thead>
<tr>
<th>SEDBUK table for target U-value method</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table 2 minimum boiler efficiencies as listed by SEDBUK</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Central heating system fuel:</strong></td>
<td><strong>SEDBUK %</strong></td>
</tr>
<tr>
<td>Mains natural gas</td>
<td>86</td>
</tr>
<tr>
<td>LPG</td>
<td>86</td>
</tr>
<tr>
<td>Oil</td>
<td>85(^1)</td>
</tr>
</tbody>
</table>

**Note:**
1. for oil fired combination boilers a SEDBUK of 82%, as calculated by the SAP-200 method, would be acceptable
2. Standard oil boilers installed after 1\(^{st}\) April 2007 are required to have an efficiency of 86%.

**Table 9.29: SEDBUK table**

**Installation**

The installation of gas-fired ducted air heaters should comply with BS 5864.

All ductwork should be reasonably sealed against air leakage at the normal operating pressure.

Electric storage systems should be installed by a member of the National Inspection Council for Electrical Installation and Contracting (NICEIC) or the Electrical Contractors Association.

The installation of ducted air heater systems should conform to the requirements of the manufacturer’s installation instructions and be installed by a registered member of the National Inspection Council for Electrical Installation and Contracting (NICEIC) or the Electrical Contractors Association.

The installation of gas-fired independent heaters should comply with BS 5871:1.

The installation of solid fuel-fired independent heaters should comply with BS 8303 (this standard is applicable to open fires without convection, room heaters, independent boilers and warm air heating appliances with natural convection).

The installation of electric storage independent heaters should be strictly in accordance with the manufacturer’s instructions.

In order to maintain stability because of their large mass, care should be taken to ensure that electric storage heaters rest on an even and level surface.

If boilers and electric thermal storage room heaters are to be mounted on a wall, extra care must be taken to follow strictly the manufacturer’s instructions regarding fixing and the minimum mounting height.

Radiators should not be painted with a metallic paint unless due allowance has been made for reduced heat emission.
9.5 Above Ground Drainage

WASTE DISPOSAL

All above ground plumbing systems should be designed to allow the unobstructed flow of waste water from an appliance to the underground drainage system. To achieve this the following points should be noted at the design and installation stages:

- Rodding access facilities should be provided at all changes of direction.
- Bends and changes of direction should be avoided in the wet part of the above ground drainage system.
- 75mm deep seal traps should always be used except
  - on a WC
  - where an appliance on the ground floor discharges directly into a trapped gully.
- Pipe sizes should not exceed the dimensions for diameter against pipe length given in table 9.30.
- Pipes should be laid at a gradient of 1/80 or better.
- Any admittance valve fitted to the system should be located above the highest flood level of any appliance connected to that stack pipe.
- Enclosures to air admittance valves should be adequately ventilated.
- The highest point of a drainage system (head of run) should always be vented to the external air.

<table>
<thead>
<tr>
<th>appliance</th>
<th>Permitted maximum length of pipework for diameter given</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>32mm</td>
</tr>
<tr>
<td>Sink</td>
<td>---</td>
</tr>
<tr>
<td>Wash hand basin</td>
<td>1.7m</td>
</tr>
<tr>
<td>Bath</td>
<td>---</td>
</tr>
<tr>
<td>Shower</td>
<td>---</td>
</tr>
<tr>
<td>Bidet</td>
<td>1.7m</td>
</tr>
<tr>
<td>WC</td>
<td>---</td>
</tr>
</tbody>
</table>

Note:

Soil and cent pipes (stacks) should be at least 100mm diameter (this can be reduced to 75mm diameter above last discharge point (wet part) when it is used purely for ventilation of the system). Length can be extended if anti-syphonic traps are used. Further guidance can be provided by the Building Regulations AD H1 and BE EN 1205.

Table 9.30: Permitted length of pipework

VENTILATION – AIR ADMITTANCE VALVES

Air admittance valves (AAV’s) provide a means of ventilation to the drainage system to prevent the loss of water seals in traps. The valve should have Third Party accreditation and the drainage system should be designed in accordance with BS EN 12056-2:2000.

Air admittance valves are suitable for use in domestic buildings e.g. bungalows, houses, multi-storey flats, halls of residence.

Air admittance valves are not suitable when the discharge stack provides the only ventilation to septic tanks or cesspools or when the connecting drain is subject to periodic surcharging or is fitted with intercepting traps.

- The 32mm valve is for connection to waste pipes where the trap seal may be lost due to self and induced siphonage.
- The 56mm valve is for use on branch discharge pipes.
- The 82mm and 110mm valves are for use on discharge stacks serving up to 10 storeys (see diagram 9.31 and 9.32).
- The 110mm valve maybe used as a substitute for the 82mm valve where the 110mm spigot diameter makes it easier to install.
- The 125mm valve is for use on discharge stacks serving up to 12 storeys.

Satisfactory drainage systems incorporating an air admittance valve are shown in diagram 9.31 – 9.33.
To contribute to the ventilation of the underground drain, the branch or main drain serving a stack or stacks fitted with an air admittance valve may require venting. (See diagram 9.33).

For other multi-storey dwellings conventional drain venting should be provided. If more than one such building, each equipped with the valves, is connected to a common drain which itself is not vented, confirmation should be sought as to the venting requirements of the drain in question.

**Positioning of air Admittance Valves**

The air admittance valve should be installed within the building taking into account the following:

- It should preferably be installed in a non-habitable space. In a roof or other space where there is a risk of freezing the insulating cover should be provided.
- It should be installed where noise of operation will not cause a nuisance. Provide sound insulation when this is not possible.
- If self-siphonage may occur, a connection to the 32mm valve is required within 300mm of the trap.

Where the air admittance valve is enclosed within a boxing the boxing should be ventilated. A free area of 2500mm$^2$ is acceptable.

The use of ventilation grilles, discreet gaps around the boxing or ventilation of the boxing into a roof void are acceptable methods of providing ventilation.

**Testing of above Ground Drainage System**

As the air admittance valve is an integral part of the above ground drainage system it should be in place when the system is tested.
Diagram 9.33: Drain ventilation provisions

Index:
A = access
B = valve
C = gully
D = conventional vent stack

Notes:
Access arrangements are indicative only and may be varied to suit particular system layouts.
The underground drain must be designed in accordance with BS 6317: 1989
If the branch drain is fitted with an intercepting trap before the connection to the main drain/effluent then a conventional open topped ventilation discharge stack must be provided at the nearest point upstream of the intercepting trap.
9.6 Ventilation

**SYSTEM DESIGN**

The system should comply with the following:

- BS 5250: Code of Practice for control of condensation in buildings
- BS 5720 Code of Practice for mechanical ventilation and air conditioning in buildings
- BRE Digest 39.

In England & Wales the Approved Document F details three main ways of complying with the requirements:

a. Providing the ventilation rates set out in paragraphs 1.4 to 1.7; or
b. Following the system set out:
   - for dwellings without basement (paragraph 1.8); This guidance covers all levels of design air permeability.
   - for dwellings with basements (paragraphs 1.9 to 1.11); or

   c. Using other ventilation systems provided it can be demonstrated to the Building Control Body that they satisfy the Requirement, e.g. by showing that they meet the moisture and air quality criteria set out in Appendix A.

Where ductwork from extractor fans passes through unheated spaces such as roof voids the following action should be taken to reduce the possibility of condensation forming within the ducting and any consequential damage caused to finishes and the fan unit:

- Ensure ducting discharges to the outside air.
- Provide insulation to the outside of the ductwork and lay to a fall away from the fan.

The system should provide the rates of change with the external air as set out in:

- Approved Document F 2010 (England & Wales)
- Technical Standards: K (Scotland).
- Part K: Ventilation (Northern Ireland)

It is a requirement that all habitable and service rooms within dwellings have some form of ventilation, whether it is permanent background ventilation, mechanical ventilation or indeed an openable window. Table 9.34 provides guidance on the provisions of extract ventilation to rooms.

For internal rooms (non-habitable), provide either 15 minutes overrun to the mechanical extraction unit, provide Passive Stack Ventilation or an open flued heating appliance may be acceptable. In all cases some form of air inlet is required.

**WHOLE BUILDING VENTILATION**

Whole building ventilation rate for the supply of air to the habitable rooms in a dwelling should be no less than specified in Table 9.35.

<table>
<thead>
<tr>
<th>Room</th>
<th>Intermittence extract Minimum rate</th>
<th>Continuous extract Minimum High rate</th>
<th>Total extract rate should be at least the whole dwelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen</td>
<td>30 l/s adj to hob; or 60 l/s elsewhere</td>
<td>13l/s</td>
<td></td>
</tr>
<tr>
<td>Utility Room</td>
<td>30l/s</td>
<td>8l/s</td>
<td>Ventilation on rate given in table 5.1b</td>
</tr>
<tr>
<td>Bathroom</td>
<td>15l/s</td>
<td>8l/s</td>
<td></td>
</tr>
<tr>
<td>Sanitary accommodation</td>
<td>6l/s</td>
<td>6l/s</td>
<td></td>
</tr>
<tr>
<td>Purge ventilation</td>
<td></td>
<td></td>
<td>Purge ventilation is required to all habitable rooms and should be capable of extracting a minimum of 4 air changed per hour per room directly to the outside. Further guidance is available in AD part F</td>
</tr>
</tbody>
</table>

Table 9.34: Ventilation requirements in dwelling installations
### 9.6 Ventilation

#### Whole building ventilation rates (l/s)

<table>
<thead>
<tr>
<th>Number of bedrooms in dwelling</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilation Whole building ventilation rates</td>
<td>13</td>
<td>17</td>
<td>21</td>
<td>25</td>
<td>29</td>
</tr>
</tbody>
</table>

Notes:
- a. in addition, the minimum ventilation rate should be not less than 0.31l/s per m internal floor area (this includes each floor), eg for a two storey building, add the ground and first floor areas.
- b. This is based on two occupants in the main bedroom and a single occupant in all other bedrooms. This should be used as the default value. If a greater level of occupancy is expected, then add 4l/s per occupant.

<table>
<thead>
<tr>
<th>Table 9.35: Whole building ventilation rates</th>
</tr>
</thead>
</table>

#### PASSIVE STACK VENTILATION

The Passive Stack Ventilation (PSV) system should comply with the recommendations contained within BRE information paper 13/94 or hold an appropriate Third Party certification such as a BBA Certificate.

**System Layout**

The PSV layout should be designed to:

- Avoid crossflow between the kitchen and bathroom/WCs
- Prevent, as far as possible, air flow in the ducts being adversely affected by the prevailing wind speed and direction, or by sudden changes in these
- Minimise resistance to air flow by having ducts that are as near vertical as possible.

The layouts shown in diagram 9.36 are considered to be suitable for the majority of dwellings of up to three storeys. Separate ducts are taken from the ceiling of the kitchen, bathroom, utility room or WC to separate terminals on the roof. A common outlet terminal or branched ducts between these rooms should be avoided as they could (usually in high wind speed conditions) result in air from one room being routed to another.

There are broadly two suitable positions for the duct outlet terminals (See diagram 9.36).

**Duct Size and Materials**

To achieve an adequate, but not excessive, air-flow rate the diameter of the ducting should be chosen in accordance with Tables 9.35 & 9.37 together with diagram 9.36. Off the shelf PVC-u pipes and fittings, of the type used for soil pipes, are suitable and have the advantages of being inexpensive, widely available and, to some extent, self-supporting.

Flexible ducting has the advantage of being easier to install where a completely vertical duct is not viable. It is also available in a pre-insulated form. There is, however, the disadvantage of the need to support any bends in a smooth curve. Tests have shown that flexible ducting and rigid ducting have similar resistance to air flow at the flow rates found in typical PSV systems.

All ventilators and pipes should be fitted with mesh grilles or be a type designed to avoid entry of birds and insects.

![Diagram 9.36: Kitchen and bathroom ducts for PSV extraction](image-url)
### 9.6 Ventilation

<table>
<thead>
<tr>
<th>Location</th>
<th>Diameter of duct (mm)</th>
<th>Internal cross sectional area (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WC</td>
<td>80</td>
<td>5000</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>100</td>
<td>8000</td>
</tr>
<tr>
<td>Utility</td>
<td>100</td>
<td>8000</td>
</tr>
<tr>
<td>Kitchen</td>
<td>125</td>
<td>12,000</td>
</tr>
</tbody>
</table>

*Table 9.37: PSV duct sizing*

**AIR TRANSFER BETWEEN ROOMS**

To ensure good transfer of air throughout the dwelling, there should be an undercut of minimum area 7600mm² in all internal doors above the floor finish (equivalent to an undercut of 10mm for a standard 760mm width door).