British Plastics Federation
PIPES GROUP

Air admittance valves for domestic properties

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Introduction

For any system which drains wastewater from a property to function correctly, the soil and waste pipes need to be ventilated. Without ventilation, air pressure changes inside the pipework due to the operation of domestic appliances would cause waste traps on the appliances to lose their water seal.

Until the early 1970's, the only way to achieve this was to install an open soil pipe (stack) through the roof, terminating outside of the property with its recognisable balloon grating or wire cage to prevent access by wildlife.

Whilst open stack ventilation is still common practice, air admittance valves have been available in the UK for over 40 years. They provide an alternative, and aesthetically more attractive, means of venting the drainage system.

This guide provides information on the function and best practice for specifying, locating and installing air admittance valves on gravity fed soil and branch pipes which discharge to a sewer.

Ventilation options

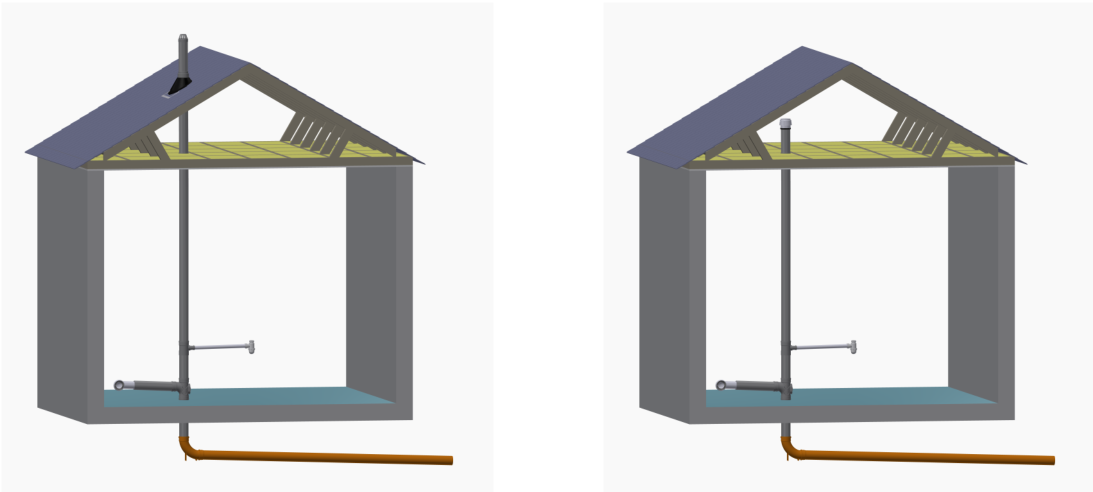
Across the UK, Building Regulations and statutory guidance allow for ventilation by either open soil pipes or air admittance valves (Figure 1). The preferred solution, being the simplest and most familiar to an installer, is the open soil pipe. It requires minimal maintenance and the visible termination point above the roof means it is less likely to be blocked off during future building work.

Open soil pipes need to terminate at least 900mm above any opening to the building, for example a window or balcony. Additionally, they require capping with a balloon grating or wire cage to prevent wildlife from seeking a warm refuge whilst not restricting the flow of air.

Air admittance valves (AAVs) are installed directly on to the soil stack without the need for a hole to be made in the property roof, reducing the amount of pipework required and the costs of making good the roof, and minimising risks of weather damage and water ingress. AAVs are normally located in the roof space and can provide the same ventilation capacity as an open system. They are particularly suitable for installation on stub stacks – a short stack from ground floor appliances which avoids the need for a full house height pipe.

Whilst not permitted by statutory guidance, except in Scotland under controlled conditions, the use of air admittance valves on the outside the property is commonly used to overcome space restrictions between the stack and a window opening or to ventilate appliances without access to the main soil stack, for example in a property extension.

Figure 1 Ventilation options

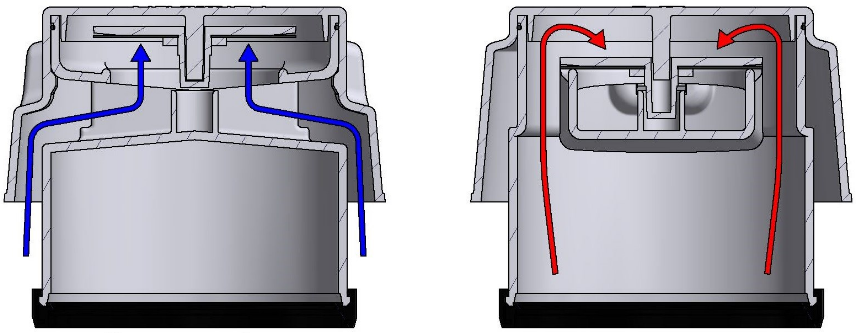


Typical soil stack | AAV terminating in roof space

Function

Air admittance valves are designed to fit to a vertical pipe inside the building. The valve prevents the escape of foul air from the drainage system into habitable areas. The valve houses a seal, usually manufactured of EDPM or silicon rubber, which lifts and falls in response to negative pressure caused by WC flushing and the draining of appliances (Figure 2). This simple mechanical principle allows air to flow into the drainage system, thereby breaking the vacuum, which would otherwise create a siphon in the traps.

Figure 2 AAV operation



Open valve | Closed valve

Regulations and Standards

Statutory requirements and guidance

The Building Regulations 2000 require that an adequate system of drainage is provided to carry foul water from appliances within a building to a sewer, septic tank or cesspit.

Across the UK, the statutory guidance interpreting these Regulations are broadly similar, all requiring that the drainage system is ventilated by an open soil pipe or the use of air admittance valves. The use and installation of AAVs inside a building is set out below.

Scotland	England & Wales	Northern Ireland
Technical Handbooks 2022: domestic Clause 3.7.8, non-domestic Clause 3.7.7	Approved Document H: 2010 Clause 1.33	Technical Booklet N 2012: Clauses 2.13 & 2.15
Allows for the installation of air admittance valves where they are fitted: • in accordance with BS EN 12380: 2002; or • in compliance with the conditions of certification of a notified body.	Allows for the installation of air admittance valves where they are fitted in accordance with BS EN 12380: 2002.	Allows for the installation of air admittance valves where they are fitted in accordance with BS EN 12056: Part 2 and BS EN 12380: 2002.

In respect of the use of AAVs in an external installation, the guidance differs slightly across the UK:

- In Northern Ireland, the guidance refers only to BS EN 12380 for inside buildings.
- In England and Wales, the guidance refers to BS EN 12380 and further states that AAVs "should not be used outside buildings".
- In Scotland, the guidance appears to offer some latitude in this respect allowing external installation where this is certified by notified body.

Product Standard

BS EN 12380 *Air admittance valves for drainage systems. Requirements, test methods and evaluation of conformity.*

This standard covers air admittance valves to be used in gravity drainage systems installed inside buildings according to BS EN 12056.

It is used by manufacturers for designing and testing products. Guidance from all key industry bodies such as CIBSE and NHBC follow the requirements of BS EN 12380.

The British Plastics Federation (BPF) Pipes Group and its members strongly advise that compliance with BS EN 12380 is verified by a third-party (UKAS accredited or equivalent).

The requirements in BS EN 12380 can be summarised as follows:

- Product Type and Requirements for: Operating Temperature Range and Installation Position, Connection type, Air Tightness, Durability, Air Flow Capacity.
- Test Methods used to assess: Impact and Handling Resistance, Air Tightness, Endurance and Temperature Cycling, Opening Characteristics and Air flow, Sub-Zero Operation.
- Evaluation of Conformity: Type Testing and Production Quality Control including CE marking and labelling.

Note: BS EN 12380: 2002 Annex ZA sets out the responsibilities of the manufacturer for demonstrating compliance with essential requirements listed in the Annex by testing and factory production control and for affixing a CE mark or a UKCA mark on the valve and packaging. The use of CE marking or UKCA marking does not replace verification by a third party of compliance with BS EN 12380. For more information on CE and UKCA marking, see www.gov.uk/guidance/ce-marking and www.gov.uk/guidance/using-the-ukca-marking.

BS EN 12380 uses a designation system for valves according to their operating temperature and location with respect to connect appliances. This is shown in the table and example below.

Determining Factor	Range / Position	Designation
Permitted to be located below flood level of connected appliances	Yes	A
	No	B
Operating Temperature Range	-20°C to 60°C	I
	0°C to 60°C	II
	0°C to 20°C	III
Source: BS EN 12380: 2002 Table 1 Operating conditions and designation of air admittance valves		

Example:

An AAV that is permitted to be installed below an appliances flood level and can operate in air temperatures of –20°C to 60°C would be designated an A I rated valve in Approved Document H and BS EN 12056-2: 2000 Section 6.

Further information on choosing a valve with the correct rating is provided in the 'Design' section of this document.

Soil and waste system ventilation

BS EN 12056-2 *Gravity drainage systems inside buildings. Sanitary pipework, layout and calculation* details the requirements for the use of air admittance valves in gravity drainage systems installed inside buildings, with particular reference to positioning and dimensions of the proposed valve as part of the chosen drainage ventilation configuration.

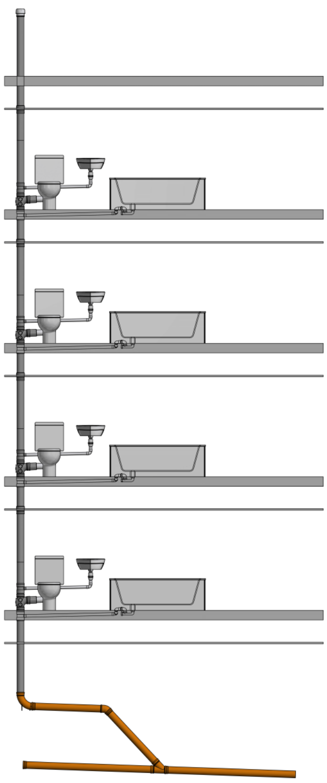
<u>Stack ventilation</u>

Soil and waste drainage systems inside buildings can be configured in a number of ways to provide adequate ventilation. These are detailed in BS EN 12056-2: 2000: Section 4, but in each case, there is a basic requirement to control air pressure fluctuations in the pipework.

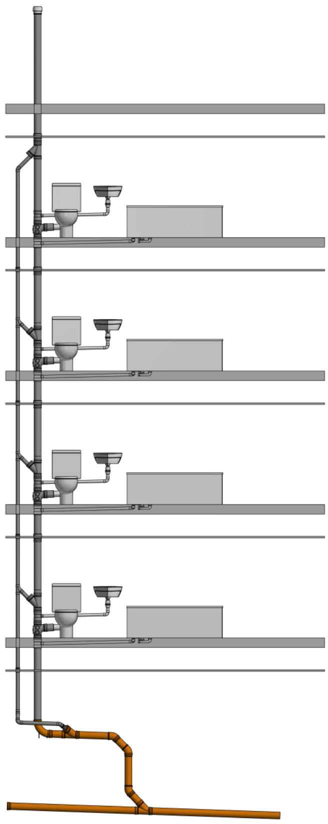
Stack ventilation is achieved through two main approaches (Figure 3):

- Primary ventilation - pressures are controlled by air flow in the main stack.
- Primary and secondary ventilation - pressures are controlled through the installation of a separate ventilating stack and/or secondary branch ventilation pipe connecting to the stack vent.

Figure 3 Stack ventilation options



Primary ventilation



Primary and secondary ventilation

Air admittance valves are suitable for both primary and secondary ventilation. Typically, they are designed to fit 110mm or 82mm pipe for stack ventilation. As foul sewer gases inside the pipe system cannot escape through the seal, AAVs can be installed inside a building, usually terminating between joists in a roof space, without a risk to public health.

Branch pipe ventilation

Where the air capacity in the branch pipework gives sufficient protection to trap seals, air pressure fluctuations are controlled without additional ventilation. General guidance for an unventilated discharge branch such as pipe size, number of appliances and pipe gradients is provided in Approved Document H and BS EN 12056-2: 2000 Section 6.

Additional ventilation may be required and can be created by installing secondary ventilation for the whole system, see above, or adding branch ventilation using smaller AAVs. Guidance on additional ventilation of branch pipework in given in Approved Document H and BS EN 12056-2: 2000: Section 4.

Air admittance valves are suitable for venting branch pipes i.e. pipework connecting to WCs, wash hand basins, baths/shower, sinks and appliances to the soil stack. Small valves are designed to fit 32mm, 40mm, or 50mm waste pipes.

Adequate pipe ventilation is required on branch pipes. This allows air to enter the system and prevents loss of a water seal in the trap due to siphonage. This might occur on the trap of a discharging appliance by self-siphonage (caused by branch pipe flowing at full bore) or the trap of an appliance which is not discharging by induced siphonage (caused by the branch pipe to which it is connected flowing at full bore or a negative pressure in the soil stack).

Branch pipe ventilation can be achieved by installing a small air AAV on an upstand, fitting anti-siphon water traps or waterless traps.

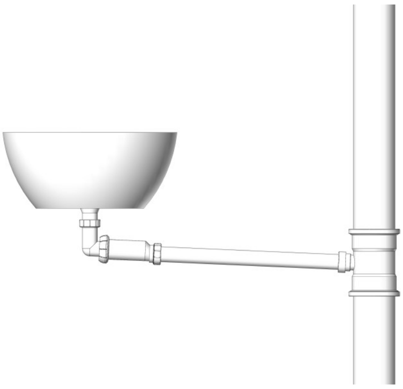
The options are shown schematically in Figure 4.

An example using the guidance in BS EN 12056-2: 2000 follows.

Figure 4 Branch ventilation options

Anti-siphon trap

AAV on upstand



Waterless trap

Secondary vent

Example of branch pipework with additional ventilation:

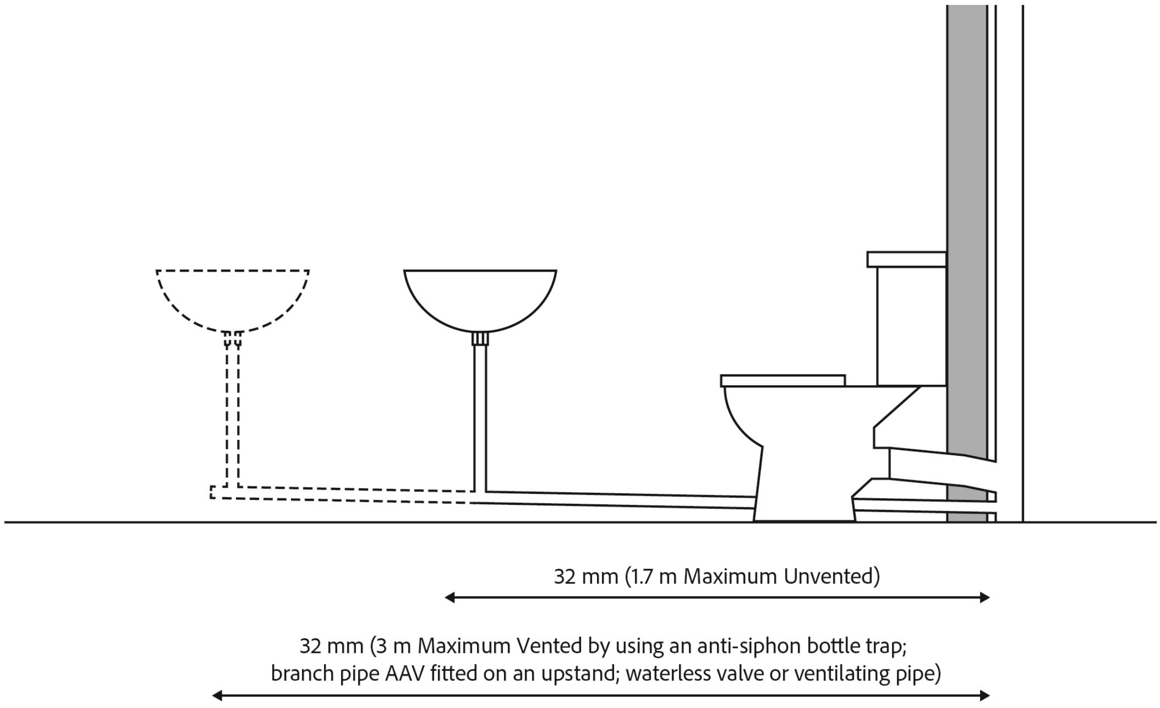
A 32mm waste pipe is connected to a washbasin.

Tables 6 and 9 of BS EN 12056-2: 2000 provide guidance on the limitations for unvented and vented discharge branches.

Table 6, row 1, shows that the maximum length of pipe from the sink waste to the stack is 1.7m (unventilated branch) but can be increased to 3m (Table 9, row 1) if the branch pipework is ventilated.

The additional ventilation required could be provided by a small AAV or using secondary ventilation.

Figure 5 Example calculation



Design

Capacity

The hydraulic capacity required of a drainage system inside a building is dependent upon the number and type of sanitary appliances connected to the system. Each appliance can be described in terms of discharge units (DU), i.e. the average discharge rate from the appliance in litres per second (l/s). BS EN 12056-2: 2000, Table 2 (column 4, System III) sets out typical discharge units - for instance, a bath is 1.3l/s, whereas as a shower without a plug is 0.4l/s.

The sum of the discharge units from all appliances connected to the drainage system are used to calculate the expected flow rate of wastewater in the drainage system, taking into account the frequency of use of appliances. Tables and formulae for calculating the hydraulic capacity required for a drainage system are set out in BS EN 12056-2:2000 Section 6. The size of a primary ventilated soil stack can then be selected using the calculated hydraulic capacity and Table 11 of BS EN 12056 -2: 2000.

Where an air admittance valve is used to ventilate a stack instead of leaving it open to the atmosphere, the minimum airflow rate is calculated from the total flow rate (Q_{tot}) from the appliances in the property. In selecting an AAV, the minimum airflow rate is eight times the total flow rate.

Example:

> Discharge units: Bath (DU = 1.3), shower without a plug (DU = 0.4), WC (DU = 1.2 to 1.7) and wash basin (DU = 0.3). Sum of discharge units = 1.3 + 0.4 + 1.7 + 0.3 = 3.7l/s.
>
> Sizing ventilated soil stack: Using section 6.3, BS EN 12056-2: 2000, for a domestic property without pumped or continuously running appliances, the total flow rate (Q_{tot}) from these appliances is the same as the wastewater flow rate (Q_{ww}) and calculated as $0.5 \times \sqrt{3.7} = 0.96$ l/s. Table 11 of BS EN 12056-2: 2000 indicates that a primary ventilated soil stack of 70mm would be suitable, but as a WC is connected to the system in our example, the minimum pipe size is 100mm.
>
> Sizing AAV: Using section 6.5, BS EN 12056-2: 2000, for the example given here the minimum air flow rate Q_a is calculated as 8 x 0.96l/s = 7.68l/s.

Whilst EN 12056-2 sets out a consistent calculation method for air flow rates, there is a range of air admittance valves available in the UK market. It is important to check manufacturer's literature to select an AAV which will meet the minimum air flow rates and deliver the performance required by the property.

Contact details for members of the BPF Pipes Group can be found at
https://www.bpfpipesgroup.com/members/member-listings/

Ratings

BS EN 12380 uses a designation system for valves according to their operating temperature and location with respect to connected appliances, see the section on 'Product Standards' in this guidance.

An AAV with designation 'A' is required to pass an air tightness test of 10 kPa (1m of water gauge pressure) in accordance with BS EN 12380: 2002 clause 6.3 and can be installed below the flood level. This is shown in Figure 6.

An AAV with designation 'B' is required to pass an air tightness test of 0.5 kPa and may only be installed above the flood level. This is shown in Figure 7.

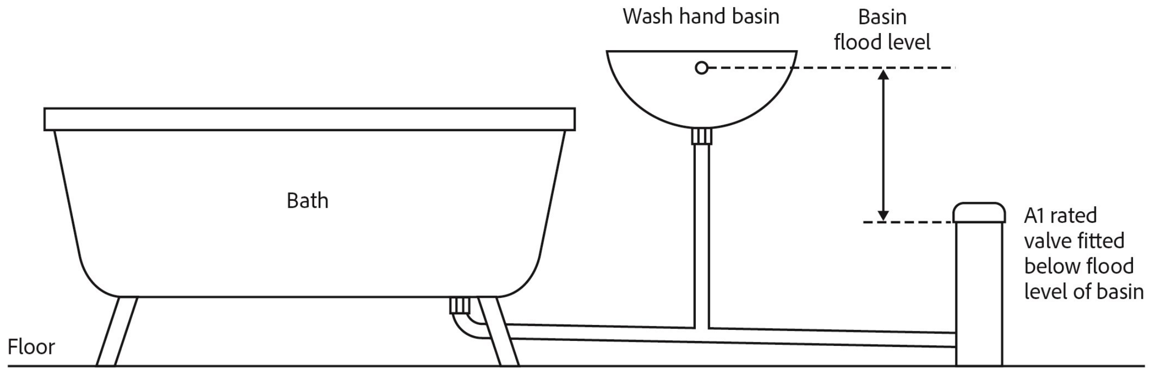


Figure 6 Installation of an AAV with designation "A"

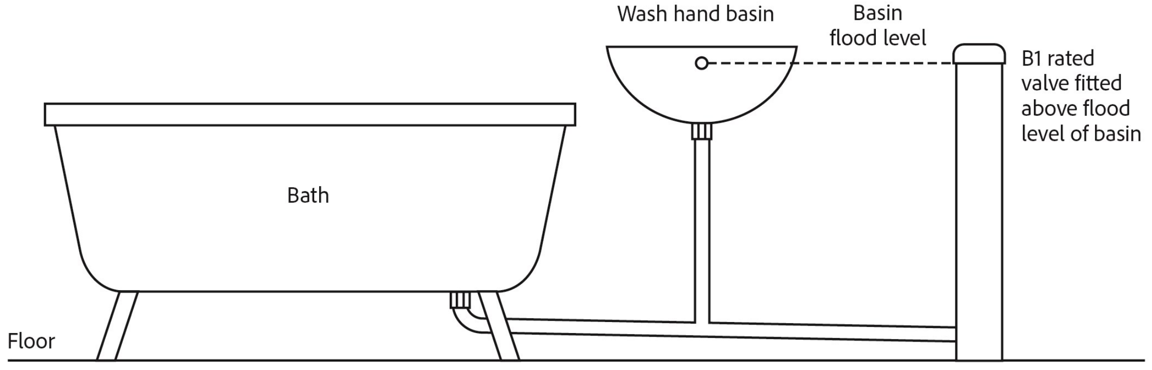


Figure 7 Installation of an AAV with designation "B"

Plot drainage

In a multiple housing situation, if all houses were fitted with an AAV, there is a risk that positive pressures in the underground system could create excessive back pressures on each connected property. Evidence of this would be "bubbling" and rising water levels in WCs and traps on other appliance.

Approved Document H1 states that where AAVs are used, they should not affect the amount of ventilation necessary.

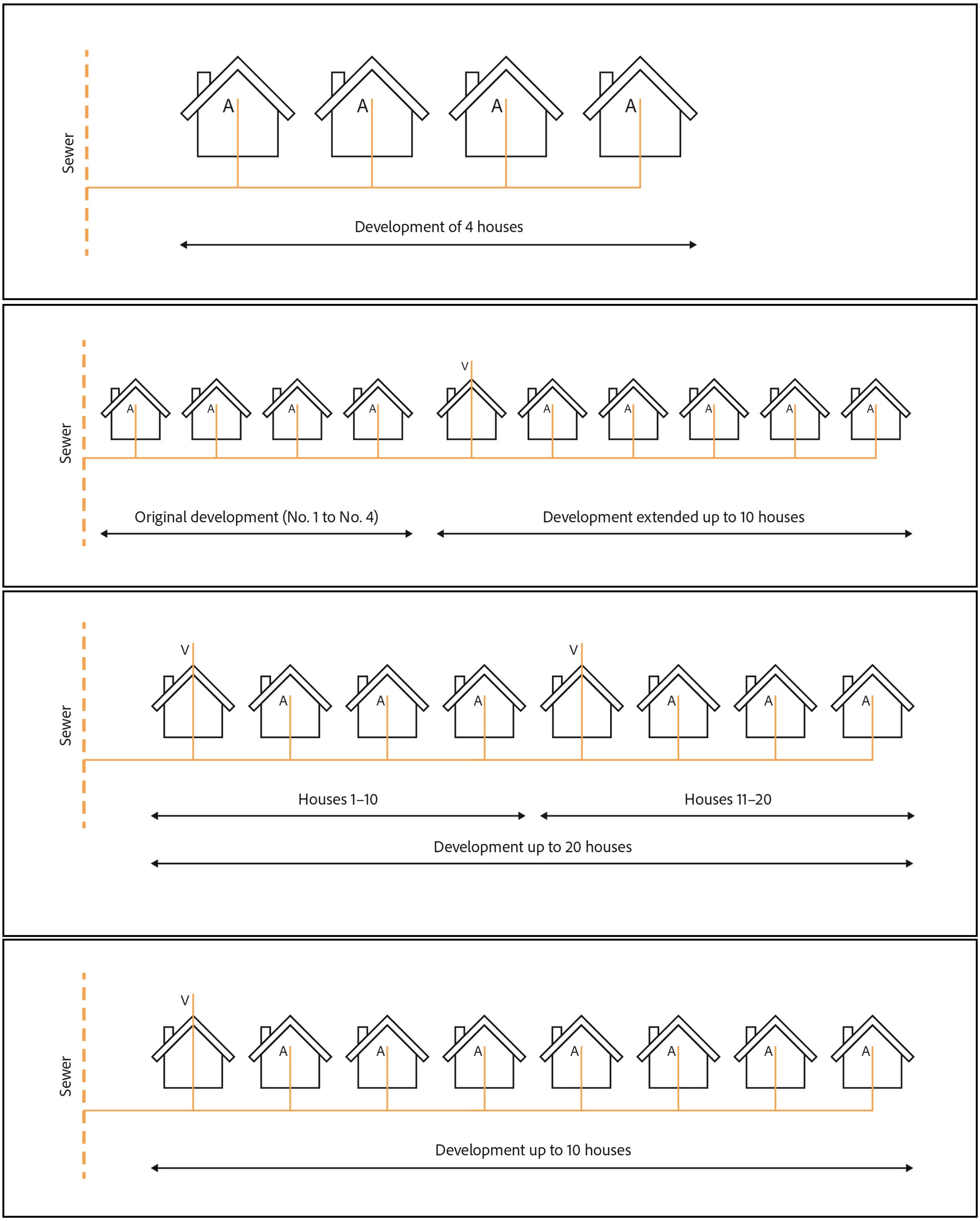
An AAV only protects the property from the effects of negative pressures in the drainage system. Positive pressures can result from various scenario (for more detail, see www.wrcgroup.com).

This risk is normally managed by installing a traditional open vent on one in ten stacks. It is important that homeowners occupying properties with an open stack vent installed for system ventilation do not compromise this during any future renovation and home improvement.

To avoid problems on any of the connected properties, the open vent is located on the property closest to the point of connection from the development to the sewer system.

Examples are shown schematically in Figure 8 for new developments of 1-4 houses, 1-10 houses and more than 10 houses. An example is also given where an existing development of 1-4 houses is extended at a later date.

Figure 8 Example installation of AAVs and open soil stacks



Location

New build properties

Good practice:

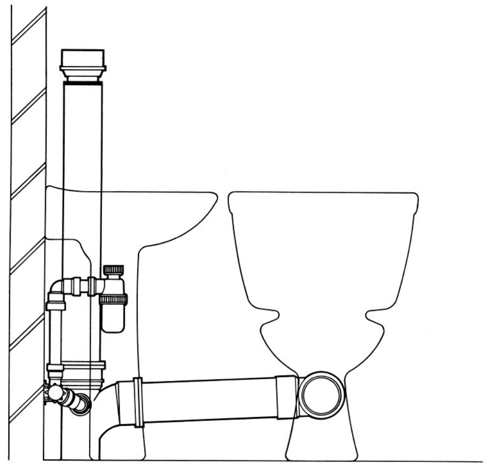
- AAV located in area with adequate ventilation – avoid restrictions to air intake.
- AAV located inside a duct or boxing – ventilate the box using grilles or gaps.
- AAV located in roof space – situate above insulation.
- AAV should be accessible for inspection, maintenance and testing.
- AAV can be used as a rodding point in the event of blockages – locate above the spillover level of the lowest appliance.

Type A valves (see section on 'ratings') may be located below the spillover level of a connected appliance. However, consideration should be given to access for inspection, maintenance and testing and flood risk. If the AAV is installed below the spillover level, the resilience of the property to flooding may be compromised. If installed above, the AAV offers a clear visual indication of a blockage before a flood occurs.

Renovations and property alterations

AAVs can also be installed on stub stacks. This presents a useful access point, but care should be taken to ensure that the AAV is accessible and that any boxing is vented.

Figure 9 Installation of an AAV on a stub stack



On the ground floor, a separate group of appliances (e.g. cloakroom) may be connected to a drain or gully using an unventilated stub stack. An AAV is not required if the vertical drop from the centre line of the WC branch to the invert level of the drain is no more than 1.5m and the centre line of the highest appliance is no more than 2.5m to the level invert of the drain. However, where stub stacks discharge directly to a drain, the head of the drain should be ventilated. AAVs are widely used on stub stacks to avoid any doubt about ventilation and to provide a convenient access point for maintenance.

Property extensions

The design of a property extension may make the venting of a soil stack through the roof space or inside the property using an AAV difficult. Except in Scotland where the valve is installed in compliance with the conditions of certification by a notified body, installation of an AAV outside of the property is not permitted by Regulation. Nevertheless, it has become common practice to do so. Designers should carefully consider the following when locating an AAV outside of a property.

Good practice:

- AAV should be tested for outside use - check suitability with manufacturer.
- Testing should include resistance to weathering including operation in low and high temperatures, protection from ingress of water, debris etc.
- AAV should be accessible for inspection, maintenance and testing.
- Instructions for maintenance should be provided to the property owner.

Installation

Good practice

It is important to follow the manufacturer's installation manual when installing air admittance valves; however, there are some general guidelines which are applicable to all AAVs.

- Keep AAV away from dusty environments – an AAV contains a lubricated seal, dust can enter the valve and stick to this seal, causing issues with the effectiveness of how the valves seals when in the closed position. It may be necessary to install the AAV at a later stage of an installation to protect them from building dust.
- Store the AAV sealed and upright.
- Different manufacturers provide their AAVs with different connection types from fin seals, spigot ended and solvent welded sockets.

- A valve which is installed with a fin seal or a spigot ended valve inserted into a ring seal will allow for removable access for rodding purposes.
- An AAV requires a free movement of air around the valve to ensure correct and effective operation. If an AAV is installed within a duct or riser it is important that this area is vented. Ventilated grilles or discreet gaps around the boxing may be an option. For further information see NHBC Technical Guidance 8.1/16.

Insulation and Condensation

Valves which are A1 or B1 rated are suitable for conditions down to minus 20°C however it may be necessary to provide insulation where there is a possibility of condensation forming and freezing within the valve body.

Installation checklist

Is it accessible?

Is there clearance around the valve (for air flow)?

Is designation correct for application?

Is it suitably installed?

Are manufacturer's instructions available & used?

Is it external? Is this permissible in region? Does manufacturer say it is suitable?

Is it 3rd party approved / mark to BS EN 12380?

Ongoing maintenance and operation

- Refer to manufacturer's installation guide for information on maintenance and operation. Some AAVs are sealed units and cannot be serviced. Some, however, can be accessed by the removal of the cap. It may be necessary on occasions to clean and re-grease any seals.
- Foul smells entering the building either through the valve or through an appliance caused by siphonage of the trap may be a sign of a faulty air admittance valve.
- AAVs act as an early indicator of blockages in the pipe system. If a blockage is forming downstream of the appliances, the WC level will be higher than usual and wash hand basins and other appliances will be slower to drain. Action can then be taken to deal with blockage before the system overflows.