A BSRIA Guide

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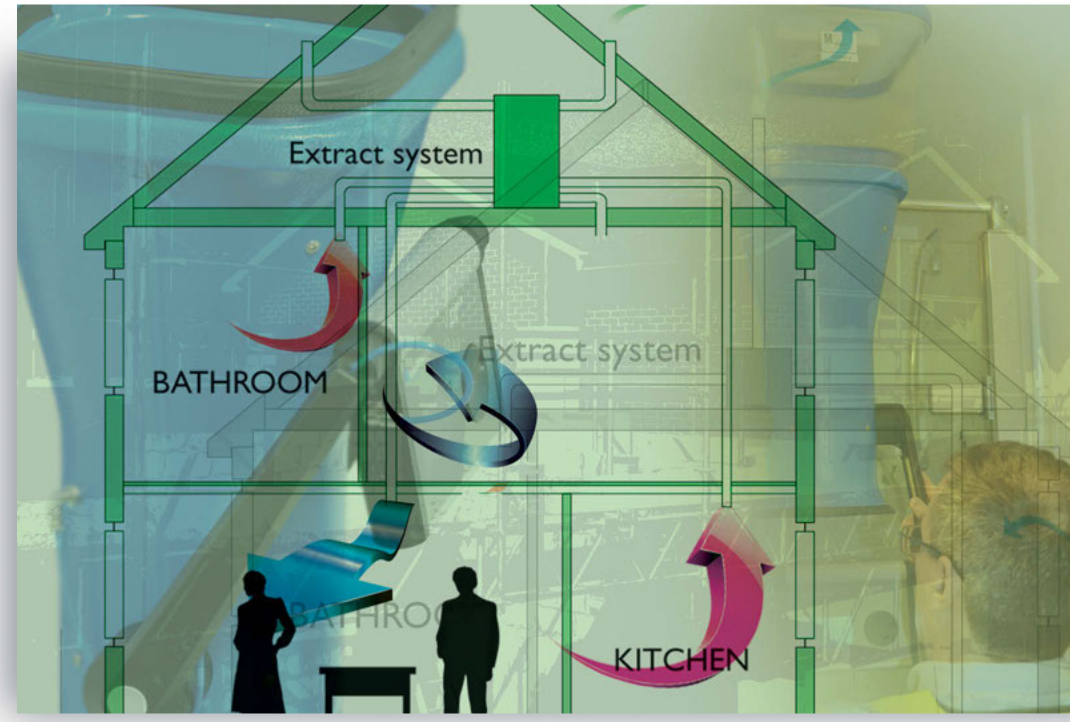
Domestic Ventilation Systems



A guide to measuring airflow rates

By Chris Knights and Alan Gilbert

Updated for 2015

BG 46/2015

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1 INTRODUCTION

The aim of this guide is to help improve the standard of domestic ventilation installations. In particular, it focuses on making sure that the methods used for measuring airflow rates are fit for purpose.

Recent changes to the Building Regulations have imposed increasingly demanding targets for energy consumption and CO_2 emissions, and established more strictly defined requirements for building airtightness and ventilation system performance. There is also increasing awareness of the important role that indoor air quality plays in the comfort and health of any building's users.

In recent years, there has been a marked increase in the use of mechanical ventilation systems in domestic properties. However, the need to balance energy efficiency, environmental impact and occupant wellbeing has consequently increased the importance of getting the design, installation, inspection, testing and handover of these systems correct.

The UK construction industry has significant room for improvement in delivering appropriate quality domestic ventilation systems. During performance tests undertaken by BSRIA in 2011, 95% of systems failed to meet the airflow rates set out in Building Regulations guidance.

The existing performance test procedures used in the domestic property sector are not robust, easily repeatable or easy to put into practice. These traditional methods can be described as "conditional methods" because the accuracy of airflow measurement is conditional on factors that are specific to the particular fan being tested and commissioned and the specific measurement device being used. Problems of using this method include:

- The use of a measurement device introduces a resistance to airflow that reduces the flow rate of air when compared to normal operating conditions of a fan. This requires the use of correction factors when calculating the actual airflow rate.
- Different measurement devices affect the airflow rates in different ways. Any correction factors employed therefore need to be specific to the particular measurement device being used.
- Each type and make of fan has a different performance curve. Any particular fan therefore reacts to the use of a measurement device in a unique way. This requires the use of fan-specific correction factors when calculating the actual airflow rate.
- Fan technology is continually evolving and changing fan performance characteristics. This means that site personnel continually require updated correction factors when using airflow measurement devices on the latest fan models.
- Airflow measurement devices are continually evolving. The performance characteristics of the latest devices differs from older models, thereby requiring the use of new, unique correction factors on site.

- Many airflow measurement devices display a reading of air velocity, not volume flow rate. The conversion of any reading into an accurate airflow rate therefore requires precise calculation of cross-sectional area of the measurement device and care with the process of converting the reading.
- Airflow measurement devices such as vane anemometers are typically calibrated for flow in one direction only. They may need to be adjusted and/or rotated when changing from measuring supply air to measuring extract air.

In response to this undesirable and potentially error-prone situation, technology has been developed that enables airflow measurements to be taken in a way that is independent of the specific "as-installed" characteristics of each domestic ventilation system.

This "unconditional" methodology uses a powered flow hood, which is designed to eliminate back pressure and turbulent flow effects. It therefore gives an accurate reading of airflow rates without the need to compensate or convert readings due to site-specific factors.

This document provides guidance about this "unconditional" measurement process, called Method A, together with guidance about the appropriate use of the "conditional" method of measurement, Method B, and the minimum benchmark method, Method C.

2 AN OVERVIEW OF VENTILATION

2.1 What is ventilation?

Ventilation is the controlled supply and removal of air from a space or spaces in a building. Ventilation is required for one or more of the following purposes:

- To provide outside air for breathing
- To dilute and remove pollutants in the air, including odours
- To control excess humidity, particularly in rooms such as bathrooms and kitchens

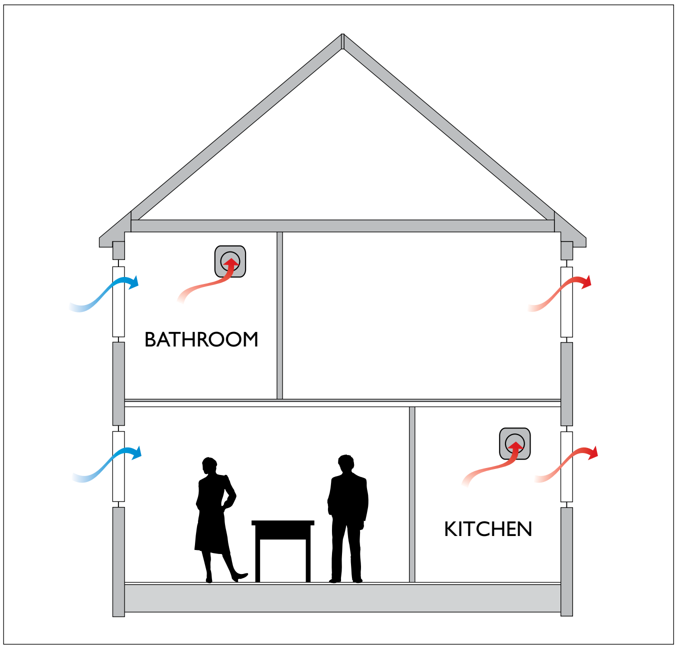
Ventilation air may also be used as a means to heat and cool buildings.

2.2 The four types of ventilation systems in dwellings

Approved Documents provide guidance about compliance with specific aspects of the Building Regulations. Approved Document F[1] describes four types of ventilation systems for dwellings, as shown below.

System 1 - Background ventilators and intermittent extract fans
In this type of decentralised ventilation system, extract fans serve wet rooms such as kitchens, bathrooms and utility rooms, providing rapid, intermittent air extraction.

Figure 1: Background ventilators and intermittent extract fans



The replacement air is provided by means of background ventilators. The term background ventilator refers to small ventilation openings that allow air to enter a building, such as trickle vents around windows or air inlet grilles in external walls.

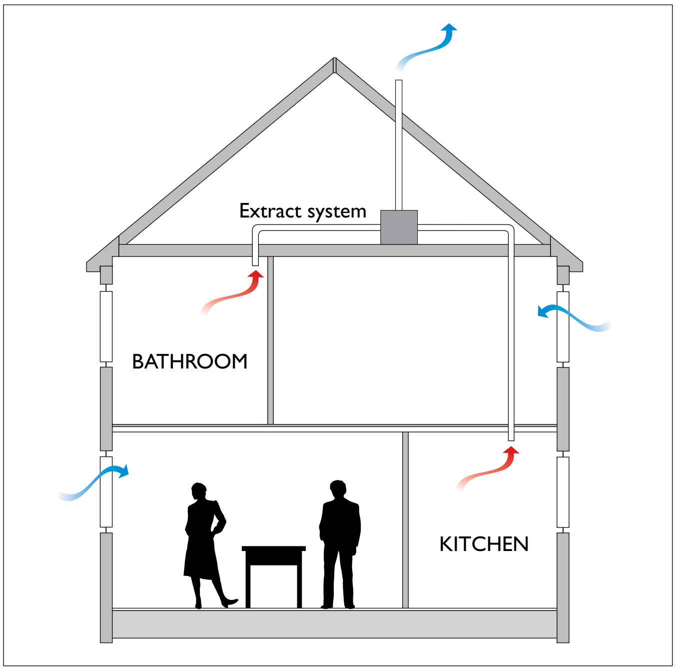
This system can be activated either by manual or automatic control.

System 2 - Passive stack ventilation (PSV)
This system comprises of vertical ducts between roof terminals and wet rooms such as kitchens, bathrooms and utility rooms. Polluted air is drawn up the ducts by wind or stack effects. The replacement air is provided by means of background ventilators.

This type of ventilation system is not covered in this guidance document because testing and commissioning are not required.

System 3 – Continuous mechanical extract (MEV)
This type of ventilation system extracts air from wet rooms such as kitchens, bathrooms and utility rooms.

Figure 2: Continuous mechanical extract



The replacement air is provided by means of background ventilators. As an alternative, where the design air permeability of the building is greater than 5 $m^3/(h.m^2)$ @ 50 Pa, background ventilators are not necessary.

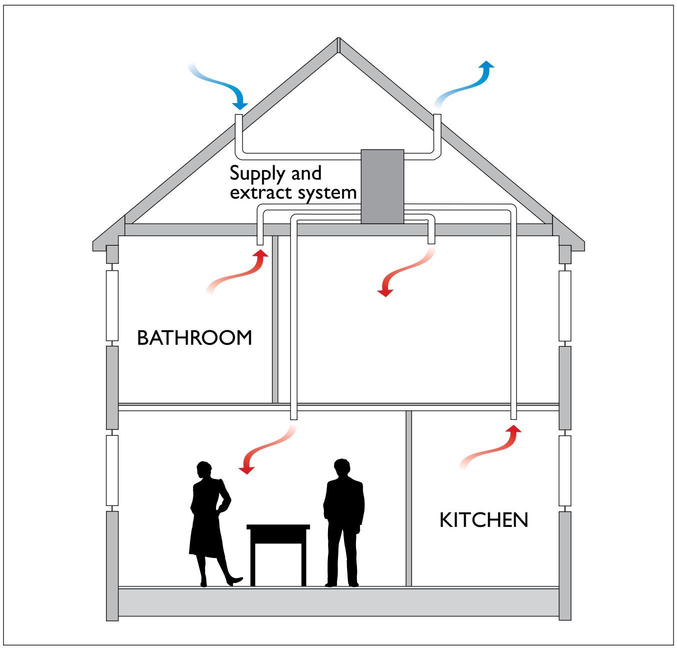
The system can be either a centralised system, comprising a single fan ducted to serve multiple rooms, or a decentralised system (dMEV) where individual fans extract air from each room.

The systems have two ventilation rates - trickle and boost. Exhaust air heat pumps would be considered as a type of centralised MEV.

System 4 – Continuous mechanical supply and extract with heat recovery (MVHR)
MVHR is a type of centralised ventilation system that combines supply and extract ventilation in one system.

Typically, warm moist air is extracted from wet rooms such as kitchens, bathrooms and utility rooms via a ductwork system and passed through a heat exchanger before being exhausted to outside.

Figure 3: Continuous mechanical supply and extract with heat recovery



Incoming fresh air is pre-heated as it passes through the heat exchanger before being supplied to habitable rooms such as the living room or bedrooms. The systems have two ventilation rates – trickle and boost.

Other types of ventilation systems, such as demand controlled ventilation (DCV) and positive input ventilation (PIV) are allowed to be used in the UK. These systems must be shown to achieve certain performance criteria, such as the removal rate of moisture or indoor pollutants, to the satisfaction of the Building Control Body.

2.3 The two types of fans used in dwellings

Domestic ventilation is normally provided by using one of two fan types: axial or centrifugal.

Axial fans

Axial fans are most typically used in the following ventilation systems:

- System 1 - Intermittent extract fans and background ventilators
- System 3 – Decentralised continuous mechanical extract systems (dMEV)

These compact types of fan are most commonly wall- or ceiling-mounted and are capable of developing pressures of up to 60 Pa. However, the capability of many models is much lower than this.

Centrifugal fans

Centrifugal fans are capable of generating pressures around 4 times greater than axial fans of the same inlet size.

This type of fan can be mounted inside a wall-mounted ventilation unit or positioned "in-line" in a length of ductwork

Centrifugal fans are most typically used in the following ventilation systems:

- System 3 – Centralised and decentralised continuous mechanical extract systems (MEV) and (dMEV)
- System 4 - Continuous mechanical supply and extract with heat recovery (MVHR)

3 PERFORMANCE REQUIREMENTS

3.1 Building Regulations requirements

The Building Regulations for England and Wales impose the following two legal requirements for ventilation in buildings:

1. There shall be adequate means of ventilation provided for people in the building.
2. Fixed systems of mechanical ventilation and any associated controls must be commissioned by testing and adjusting as necessary to meet the above objective.

The Building Regulations also state that the persons installing ventilation systems need to comply with these requirements by doing the following:

- Prove that an adequate means of ventilation has been provided for people in the building by ensuring that the testing of the mechanical ventilation airflow rate is carried out in accordance with a procedure approved by the Government
- Give a notice of the test results to the Building Control Authority no later than 5 days after the final test is carried out
- Provide the test results to the Building Control Authority, together with a notice that the mechanical ventilation system has been commissioned in accordance with a procedure approved by the Government. This needs to be done no later than 5 days after the final test is carried out.

Approved Document F[1] sets out approved methods of meeting the above legal requirements for ventilation systems. Approved Document F is supported by another important guidance document – Domestic Ventilation Compliance Guide[2] – which provides additional detail about how to comply with the requirements for installation, inspection, testing, commissioning and provision of information. The Domestic Ventilation Compliance Guide states that instrumentation used for measuring airflow rate must provide a measurement accuracy of ± 5%.

Figure 4: Approved Document F and the Domestic Ventilation Compliance Guide

3.2 Building Regulations guidance

Approved Document F gives three methods of compliance for new dwellings:

1. Providing the ventilation rates shown in tables 1 and 2 below. No guidance is given on what systems or equipment should be employed to achieve these ventilation rates.
2. Following the guidance provided for the four types of systems outlined in section 2.2 of this publication. Where mechanical ventilation is used for either supply or extract, the ventilation rates are as shown in tables 1 and 2 below. Where trickle vents are employed, sizing charts are provided.
3. Meeting the performance criteria set out in Appendix A of Approved Document F. These criteria are exposure levels of various indoor air pollutants, and it is generally accepted that this method is provided for reference only, and few dwellings will be designed this way.

Table 1 : Extract ventilation rates for different types of room

Extract ventilation rates			
Room type	Intermittent extract	Continuous extract	
	Minimum rate	Minimum high rate	Minimum low rate
Kitchen	30 l/s adjacent to hob; or 60 l/s elsewhere	13 l/s	Total extract rate should be at least the whole building ventilation rate given in Table 2
Utility room	30 l/s	8 l/s	
Bathroom	15 l/s	8 l/s	
Sanitary accommodation	6 l/s	6 l/s	

Table 2 : Whole building ventilation rates

Whole building ventilation rates					
	Number of bedrooms in dwelling				
Whole building ventilation rate[a,b] (l/s)	1	2	3	4	5
	13	17	21	25	29

Notes:

a. In addition, the minimum ventilation rate should not be less than 0.3 l/s per m^2 of internal floor area. (This includes all floors, e.g. 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 add 4 l/s per occupant.

Detailed guidance about ventilation rates is beyond the scope of this document. However, with reference to Table 2 above, one important requirement to note is that for systems 3 and 4 the minimum ventilation rate should not be less than 0.3 l/s per m^2 of the total internal floor area. Project teams commonly fail to take this into account, which results in undersized fans being installed or incorrect testing and commissioning of ventilation systems.

Construction professionals should refer to Approved Document F[1] for detailed guidance about ventilation requirements in dwellings. A worked example of a ventilation calculation ia given in appendix A.

4 INSTALLATION OF DOMESTIC VENTILATION SYSTEMS

Poor quality installation of flexible ductwork is the principal cause of ventilation problems in domestic buildings. Flexible ductwork that is too long, has too many bends, or is poorly supported can have serious detrimental effects on both ventilation rates and system energy consumption because of the increased resistance to airflow that it introduces.

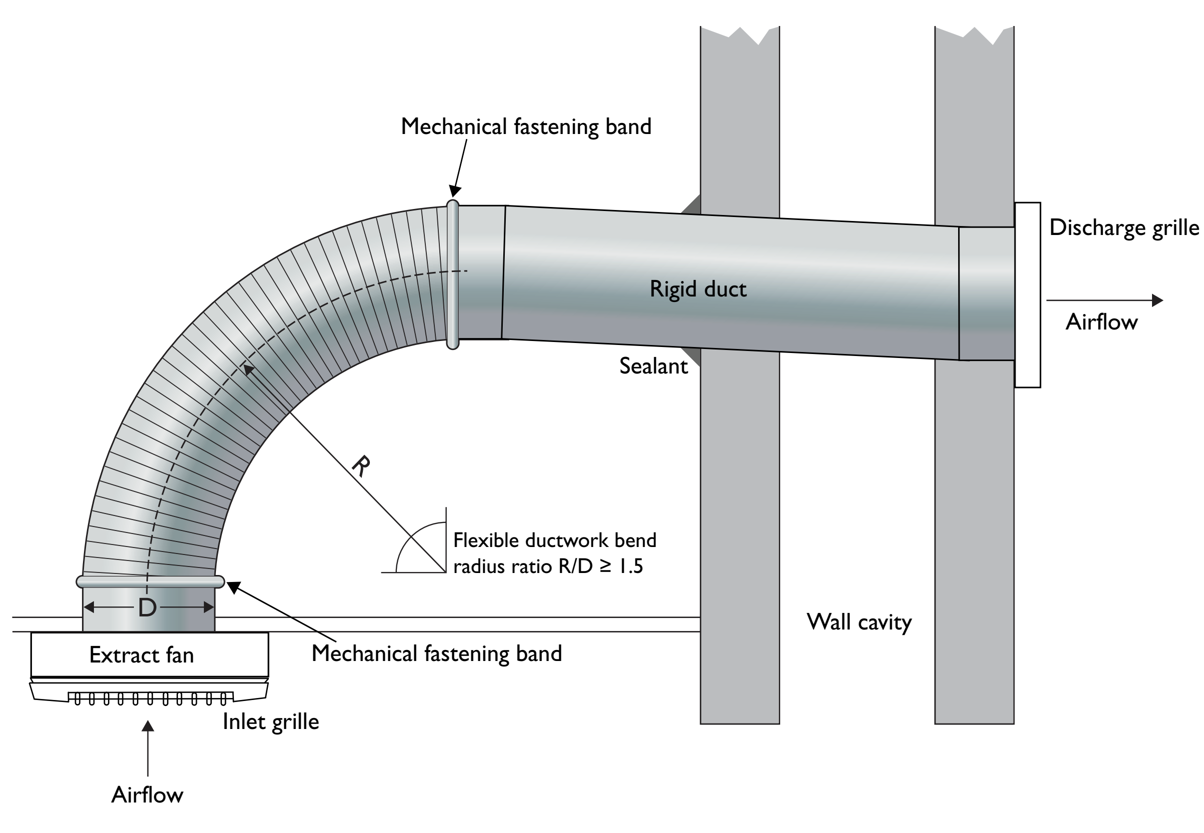
Best practice guidance about flexible ductwork installations is provided in BSRIA publication BG43/2013[4]. Recommendations applicable to domestic ventilation are summarised below:

- Flexible ductwork should only be used to make final connections to ventilation units, grilles or diffusers.
- Flexible ducts should be extended to 90% of their maximum length to ensure that the full internal diameter is obtained and flow resistance minimised.
- Flexible ducts should be adequately supported to eliminate sagging and kinking – a maximum interval between supports of 600 mm is recommended.
- Flexible duct should not be run through floors and walls.
- Flexible ducts should not be installed where they can be damaged, such as across loft areas where they may be stood on or have items placed on them, crushing the duct and restricting or preventing all air flow through the duct.
- Connection of lengths of flexible duct must use a rigid connector and jubilee clips or similar to ensure a long-term seal is achieved. Connections of lengths of flexible duct should not be taped-only.
- The integrity of flexible ductwork depends on the successful application of the correct sealant, gaskets or tape. The materials used should be suitable for the purpose intended.
- Where flexible ductwork is to be insulated, it should be factory applied.
- In order to help prevent the accumulation of condensation, flexible ductwork should be installed with a gradient towards the discharge grille.

Additional guidance on the use of flexible ductwork in domestic ventilation, including maximum lengths, can be found in the Domestic Ventilation Compliance Guide[2].

When installing ductwork across a wall cavity, great care needs to be taken to ensure that cavity insulation does not enter the ductwork. Figure 5 shows best practice installation guidance for ductwork. It is based on a diagram shown in the Domestic Ventilation Compliance Guide[2].

Figure 5: Diagram showing recommended installation practice for ductwork



5 THE MEASUREMENT OF AIRFLOW

There are three different airflow measurement methods that can be used for domestic ventilation installations – the unconditional method, the conditional method and the minimum benchmark method.

This section of the guide provides a brief overview of each method and the instrumentation that can be used with each method.

5.1 THE UNCONDITIONAL METHOD (METHOD A)

The unconditional method of airflow measurement is the preferred method in all installation scenarios because of its accuracy and simplicity. As its name suggests, it is a method that is free from site-specific conditions such as fan type, fan model, airflow direction and instrumentation characteristics.

This measurement method uses a powered flow hood as shown in Figure 6 below.

Figure 6: Powered flow hood

Picture courtesy of Observator

A powered flow hood is an air volume flow meter designed to eliminate back pressure and turbulent flow effects. There are a number of different types and hood configurations, but the operating principle of each instrument type is the same.

The operation of this device is based on a zero-pressure method, which compensates for the resistance of the measurement instrument and the characteristics of the air distribution system. The measurement system also senses the direction of flow, which means that the unit can be used to measure supply or extract systems without any change in configuration.

The unit incorporates a fan which rotates at a controlled speed. This means that the device is able to achieve a zero-pressure balance in the hood measurement system when placed over the inlet or outlet of a fan. As soon as the zero-pressure state is achieved, which is normally between 4 and 20 seconds, the instrument displays the air volume flow rate. Some instruments may also display the air temperature.

A variety of flow hoods can be fitted to the device to enable measurement of airflow on different sizes of grilles and diffusers.

5.2 The conditional method (Method B)

Whilst the unconditional method of airflow measurement is the preferred method for all types of domestic system, the conditional method can still be employed for some types of installation.

However, as its names indicates, the conditional method needs to take into account specific site conditions such as fan performance characteristics, the resistance to airflow created by the measurement device and assorted correction and conversion factors depending on the type of measuring instrument used. It is a testing and commissioning process that requires great care to get consistently right on site.

A wide variety of traditional instrumentation can be employed in this method. Devices include rotating vane anemometers, air capture hoods, thermal anemometers, thermal capture hoods, differential pressure anemometers and pressure pans.

One of these types of instrument - the rotating vane anemometer – is used to illustrate the particular conditions that need to be taken into account each time one of these devices is used on site.

There are many types of vane anemometer on the market, each with its own unique performance characteristics. Figure 7 shows two of these types.

Figure 7: Rotating vane anemometer

Picture courtesy of TSI

Picture courtesy of Testo

When measuring fan performance, the use of a rotating vane anemometer will affect the airflow profile through the fan. This is sometimes described as "back pressure" or "added resistance". The extent of this effect will be dependent on the specific fan performance curve and the particular characteristics of the anemometer being used. Different combinations of rotating vane and capture hood affect airflow rate in different ways.

Laboratory testing on multiple domestic fans has shown that, when using the same measurement device, it is not possible to use the same correction factor to arrive at an accurate measured airflow rate for each fan type. For further information see BSRIA Report, 57015/2[3].

The use of a small vane head is likely to result in significant back pressure or resistance being applied to the fan under test, which could result in the fan stalling and inaccurate readings. The recommended minimum vane diameter for one of these devices is 100 mm.

A rotating vane anemometer is normally supplied calibrated for one direction of flow only. It will need to be reversed in the flow hood when changing from measuring supply to extract performance. This may also require a change of flow coefficients within the instrument.

Measurement of fan performance should not be undertaken by using an anemometer without a hood. This approach will need to involve calculation of the "free area" of the air inlet or outlet grille and is very unlikely to achieve an accurate measurement of airflow rate.

Great care needs to be taken when using circular measurement hoods. This is because these devices can create venturi effects in the flow of air that result in inaccurate readings of airflow rate. For this reason, BSRIA does not recommend the use of these devices.

When placing a flow measurement hood over an air inlet or outlet, it is good practice to make sure that the hood's width and height are a minimum of 50 mm greater than that of the inlet or outlet. In order to achieve best measurement accuracy, the hood should always be positioned centrally over the air inlet or outlet

5.3 The minimum benchmark method (Method C)

This method has been established to allow the testing of axial type fans in System 1, where correction factors specific to the fan and test equipment combination have not been generated. Vane anemometers are used to provide an indication of compliance. Minimum benchmark values have been set that allow for the typical performance degradation associated with the use of vane anemometers due to the back pressures they apply to the ventilation system. The method cannot provide an accurate measurement of airflow rates. However, a guidance note published by NHBC[5] states that where minimum levels have been achieved "…it would be reasonable for BCB to assume that the fan is performing to the required level and accept the test results as showing compliance with Part F of the Building Regulations". These minimum benchmark values are shown in table 3.

Table 3: Minimum benchmark values

Fan Rating	Minimum benchmark performance
15 l/s	12 l/s
30 l/s	24 l/s
60 l/s	35l/s

It should be noted that due to different fan and equipment characteristics, testing to benchmark levels can result in compliant installations being deemed non-compliant, and non-compliant installations being deemed compliant.

5.4 Correct calibration of instrumentation for airflow measurement

Whatever type of measurement method is employed on a construction project, the correct type of instrument needs to be used and it needs to be correctly calibrated.

The Domestic Ventilation Compliance Guide[2] states that the instrumentation must be calibrated annually at a UKAS accredited laboratory. It also states that instrumentation used for measuring airflow rate must provide a measurement accuracy of ± 5%.

The UKAS calibration certificate will provide readings for reference flow to indicated flow across the required flow range. The calibration is carried out in laboratory conditions, so the certificate will give an indication of any correction that needs to be made to the instrument when in use on site.

It is important not to assume that the certification supplied as standard with the instrument is compliant with the above requirements. Frequently, the certification supplied as standard by manufacturers or equipment suppliers is non-compliant.

The following key points need to be considered when determining whether airflow measurement instruments have been correctly calibrated:

- The complete instrumentation assembly, such as an anemometer and any additional hoods, must be calibrated together as a working measurement system.
- The equipment must be calibrated annually. Tests performed outside of the annual calibration period will not be valid.
- The equipment must be calibrated at a UKAS accredited laboratory and a UKAS certificate needs to be available for inspection. Calibrations that are "traceable to UKAS" are non-compliant.
- The equipment must be calibrated for volume flow. Calibrations for velocity are non-compliant.
- The equipment must be calibrated over the range for which it used. Measurements taken outside of the calibrated range are non-compliant.
- Where the airflow measurement instrument utilises a correction factor – often referred to as the k factor or area factor – for its associated hood(s), the correction factor stated on the calibration certificate must be used for all tests on site. Note that different correction factors may exist for different hoods and for supply and extract directions of airflow. Where site airflow tests are performed without using the appropriate correction factors, the test will be non-compliant.

6 TESTING AND COMMISSIONING VENTILATION SYSTEMS

6.1 Different methods

An overview of the different types of centralised and decentralised domestic ventilation systems was given in Section 2 of this document. Section 4 of this document provided an overview of the three different types of measurement techniques – the conditional method, the unconditional method and the minimum benchmark method.

This section of the guide brings these together to show how to validate the performance of centralised and decentralised domestic ventilation systems.

The unconditional method is the preferred method in all scenarios because of its accuracy and simplicity. However, table 4 illustrates which measurement method can be applied to each particular type of ventilation system.

Table 4 : Airflow measurement methods for different types of ventilation system

	System 1 Intermittent extract fans	**System 3** Mechanical extract ventilation		**System 4** Mechanical ventilation with heat recovery (MVHR)
	Decentralised	Decentralised (dMEV)	Centralised (MEV)	Centralised
Method A Unconditional measurement method	Yes	Yes	Yes	Yes
Method B Conditional measurement method	ONLY with specific correction factors for both the instrument and the fan	ONLY with specific correction factors for both the instrument and the fan	Not preferred	Not preferred
Method C Minimum benchmark method	Yes	No	No	No

The back pressure that Method B produces increases as the airflow rate increases. In ventilation systems that use axial fans, this will inevitably cause the measurement to fall outside the ±5% measurement accuracy required by the Domestic Ventilation Compliance Guide[2]. For System 1 and decentralised System 3, correction factors will need to be used in accordance with the measurement instrument being used and the performance curve of the particular fan that has been installed.

Centralised System 3 and System 4 installations typically use centrifugal fans, which are able to overcome more system pressure loss than axial fans. Whilst the use of Method B will have an effect on airflow rate, it may be possible to achieve a measurement within the ±5% accuracy tolerance allowed.

6.2 Testing and commisioning procedures

Table 5 : Testing procedure for system 1

	Testing procedure
System specification	Confirm the system type and airflow requirements for each fan by comparison with Table 5.1 in Approved Document F[1]. Pay particular attention to any specific controls requirements.
Preparation - Dwelling	Prepare the dwelling for test: 1. Open all background ventilators, except in the room where the measurement is being taken. 2. Close all internal doors & all external windows and doors.
Preparation - Instruments	Ensure that the measurement device has been configured correctly. Check: 1. The instrument is within calibration (enter details on the test sheet). 2. The equipment is functioning correctly. 3. Airflow coefficients, specific to instrument and hood assembly being used, have been correctly entered (applicable to Methods B & C only). 4. The instument is correctly configured for measuring extract flow rate (applicable to Methods B & C only).
Airflow measurements	1. Place the measurement device over the fan/terminal. 2. Ensure that the extract terminal is centred within the measurement device. 3. Ensure that the measurement device has made a positive seal to the surrounding area of the fan. Where the fan is located on an uneven surface, such as textured wallpaper or artex ceilings, the measurement device should be temporarily sealed to the surface. 4. Allow the instrument to stabilise and record the result on the test sheet. 5. Repeat for all fans/ terminals. 6. Correct the measured airflow rates for the specific fan make and model and instrumentation used for the test (applicable to Method B only). 7. Enter corrected values on to the test sheet. 8. Confirm compliance with the minimum ventilation rates for each type of room or, for Method C, confirm compliance with minimum benchmark values.
System controls	Check that the controls are operating correctly. This will include checking: means of electrical isolation, location of controls and operational requirements, such as over-runs.

Table 6 : Testing procedure for system 3 and system 4

	Testing procedure
System specification	Confirm the system type and airflow requirements for each fan by comparison with Table 5.1 in Approved Document F[1]. Pay particular attention to any specific controls requirements.
Preparation - Dwelling	Prepare the dwelling for test: 1. Open all background ventilators, where applicable. 2. Close all internal doors & all external windows and doors.
Preparation - Instruments	Ensure that the measurement device has been configured correctly. Check: 1. The instrument is within calibration (enter details on the test sheet). 2. The equipment is functioning correctly. 3. Airflow coefficients, specific to instrument and hood assembly being used, have been correctly entered – applicable for Method B only. 4. The instument is correctly configured for measuring extract flow rate (applicable to Method B only).
Airflow measurements	1. Set the system to run in trickle mode. This may involve multiple fans for decentralised systems 2. Place the measurement device over the terminal. 3. Ensure that the terminal is centred within the measurement device. 4. Ensure that the measurement device has made a positive seal to the surrounding area of the fan. Where the fan is located on an uneven surface, such as textured wallpaper or artex ceilings, the measurement device should be temporarily sealed to the surface. 5. Allow the instrument to stabilise and record the result on the test sheet. 6. Repeat at all terminals. 7. Correct the measured airflow rates for the specific fan make and model and instrumentation used for the test (applicable to Method B for decentralised systems only). 8. Enter corrected values on to the test sheet. 9. Confirm compliance with the minimum ventilation rates for each room. 10. Confirm the sum of the trickle rates meets the "whole dwelling ventilation rate" requirements. 11. Set the system to run in boost mode and repeats steps 2-8. 12. Confirm that each room boost rate meets the requirements for that room. 13. Confirm the minimum whole dwelling extract ventilation rate is at least the whole dwelling ventilation rate. 14. Confirm that the supply and extract rates are balanced in trickle and boost modes (applicable to System 4 only). 15. Confirm the total supply air has been distributed in proportion to the volumes of the habitable rooms (applicable to System 4 only).
System controls	Check that the controls are operating correctly. This will include checking: means of electrical isolation, location of controls and operational requirements, such as activation of boost function.

If the correct airflow rates are not observed at each terminal, the ventilation system will need to be re-commissioned. Refer to Table 7 for decentralised systems.

Table 7 : Commissioning procedure for decentralised ventilation systems

System type		Commissioning procedure
Decentralised	System 1 - Intermittent Extract Fans	Most fans used for this type of ventilation system will be fixed speed fans. In these instances, no adjustments can be made. Where variable speed fans have been installed, adjust the fan speed such that the design flow rate(s) is measured. The flow rate must always be measured with the fan in-situ and all covers in place, as some covers cause a resistance to the fan that reduces the flow rate.
	System 3 – Mechanical extract ventilation (dMEV)	Most fans used for this type of ventilation system will be dual speed fans, often referred to as trickle speed and boost speed. Where variable speed fans have been installed, adjust the fan speed such that the design flow rate(s) for both trickle and boost are observed. The flow rate must always be measured with the fan in situ and all covers in place, as some covers cause a resistance to the fan that reduces the flow rate.

The procedure outlined in Table 8 is the industry standard for commissioning a centralised ventilation system. However, it has shortcomings when used with measurement method B described in this guide.

This is because it requires a large flow rate of air to be passed through the system's index terminal. This generates significant back pressure in traditional measurement devices, which causes the reading of air flow rate to be lower than the actual air flow rate. The consequence of this is that the fan speed is then increased to compensate, therefore producing a ventilation system that is moving more air than required.

In order to produce a correctly commissioned system, the following procedure should only be used with measurement method A described in this guide.

Table 8: Commissioning procedure for centralised ventilation systems

System type		Commissioning procedure
Centralised	System 3 – Mechanical extract ventilation (MEV)	For centralised MEV systems, the damper of the terminal furthest away from the fan should be opened. This terminal is known as the index terminal. All other terminal dampers should be closed. The fan extract boost speed should be set so that the sum of the individual boost airflow extract rates is observed at the index terminal. All other terminals should then be adjusted, so that the required flow rates are observed at every terminal. The fan extract trickle speed should be set such that the sum of the airflow measurements at each terminal is not less than the whole dwelling ventilation rate. Once all adjustments have been made, final measurements can be taken, as described in Table 6. Terminals should be locked in position once commissioning has been completed.
	System 4 - Mechanical ventilation with heat recovery (MVHR)	In order to commission fan extract airflow rates, the same procedure described for a centralised system 3 should be used. The supply airflow rates should be commissioned in the same way, starting in the supply trickle mode. The whole dwelling ventilation rate must be observed at the index terminal. The total airflow rate should then proportionally distributed, based on the volume of each habitable room being supplied. The fan supply boost speed should be set such that the sum of the airflow measurements at each terminal is equal to the boost extract rate. Successful commissioning should result in the supply and extract airflow rates being balanced. Terminals should be locked in position once commissioning has been completed.

If the procedure in Table 8 is adopted using measurement method B, all terminals should be fully opened at the start of the procedure and the fan speed should be adjusted to make sure that the sum of the recorded airflows is equal to the total design air flow rate required. All terminals should then be adjusted, so that the air flow rate at each terminal is at the correct design value.

Once the commissioning procedures described in Tables 7 and 8 are complete, the test procedures described in Tables 5 and 6 should be undertaken.

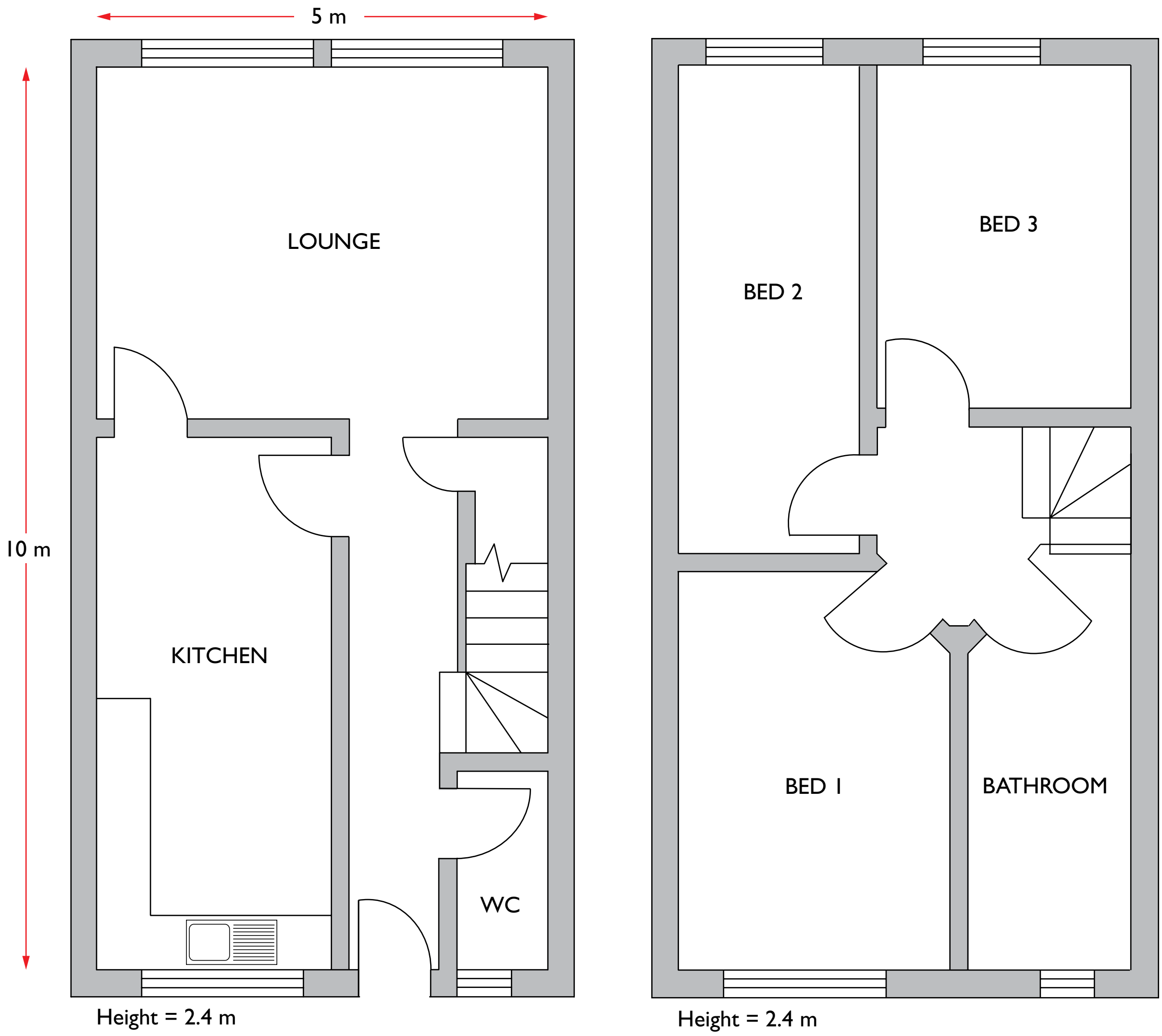
6.3 PROVISION OF INFORMATION TO BUILDING CONTROL

The Building Regulations require project teams to provide evidence to the Building Control Authority that proves that ventilation rates are correct and that the mechanical ventilation system has been commissioned in accordance with the approved procedure. This needs to be done no later than 5 days after the final test is carried out.

The Domestic Ventilation Compliance Guide[2] states that compliance with statutory ventilation requirements should be proven by the completion of all 3 parts of the checklist and test sheet provided in the document.

APPENDIX A WORKED EXAMPLE OF A VENTILATION CALCULATION

A three bedroom house with an expected occupancy of 5, is fitted with ventilation type 4 – Continuous supply and extract with heat recovery (MVHR). The air permeability of the dwelling is less than 5 $m^3/(h.m^2)$ @ 50 Pa



To establish the Whole Dwelling Ventilation Rate, three variables need to be considered:

Criteria	Value	Approved Document F[1]
Floor area	100 m^2	30 l/s
Bedrooms	3	21 l/s
Occupants	5	25 l/s

Of the three variables above, it is the building floor area that requires the most ventilation. The Whole Dwelling Ventilation Rate is therefore 30 l/s. In fan trickle mode, the total airflow rate of 30 l/s must be delivered to the habitable rooms in proportion to their volume.

Habitable room type	Room volume (m^3)	Room ventilation rate(l/s)
Lounge	46.8	10.82
Bedroom 1	30.7	7.10
Bedroom 2	25.9	5.99
Bedroom 3	26.4	6.10
Total	129.8	30.00

The boost extract rate is in accordance with the values specified in Approved Document F of the Building Regulations, as follows:

Room type	Ventilation requirements (l/s)
Kitchen	13
WC	6
Bathroom	8
Total	27

As the total boost ventilation rate calculated above is less than the whole dwelling ventilation rate, it must be must be increased to match the whole dwelling ventilation rate.

This is done proportionally for each room, as detailed below

Room type	Ventilation requirements (l/s)
Kitchen	14.4
WC	6.7
Bathroom	8.9
Total	30.0

As both the trickle and boost rates are the same, it is usual practice that the boost rate is increased such that a noticeable difference can be observed by the occupant.

REFERENCES

Throughout this publication various references are made to current England and Wales Building Regulations and Approved documents and second tier documents. Separate Building Regulations and Approved Guidance exists in Scotland, Northern Ireland and other jurisdictions. Starting in 2013 the Welsh Government started to introduce separate Building Regulations from England. However, at the time of writing, the Building Regulations documents referred to in this guide apply in both England and Wales. Further information on Building Regulations and Approved guidance can be found on the following websites:

England:	www.planningportal.gov.uk
Scotland:	www.scotland.gov.uk/bsd
Northern Ireland:	www.buildingregulationsni.gov.uk
Wales:	www.wales.gov.uk/topics/planning/buildingregs

The following documents can all be downloaded from www.planningportal.gov.uk :

1. Approved Document F 2010: Ventilation.
2. Domestic building services compliance guide 2010.

The following report can be downloaded from www.bsria.co.uk/goto/57015-2 :

3. BSRIA report 57015/2 *Flow measurement for Domestic Ventilation Fans.*

The following publication can be obtained from the BSRIA bookshop (www.bsria.co.uk/bookshop; 01344 465 529).

4. BSRIA Guide BG 43/2013: *Flexible ductwork, a guide to specification, procurement, installation and maintenance.*

The following guidance note can be downloaded from www.nhbc.co.uk:

5. NHBC Building Regulations Guidance Note: *Evidence of mechanical ventilation flow rate testing - testing of fixed axial fans.*

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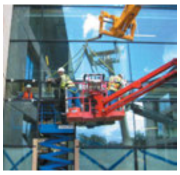


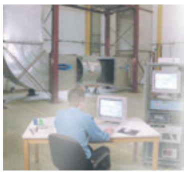

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