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GUIDANCE FOR IMPROVING INDOOR AIR QUALITY IN EXISTING HOMES

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VERSION 1 – JUNE 2023

The Risk of Poor Indoor Air Quality in Existing Homes

We spend around 90% of our time indoors[1] and around 16 hours a day on average at home.[2]

In 'normal' times, we spend around 90% of our time indoors[1] and around 16 hours a day on average at home[2]

This means that our potential risk of exposure to indoor air pollutants is significantly greater than that of outdoor air, especially considering that indoor air can be many times more polluted than outdoor air.

Poor indoor air quality (IAQ), or indoor air pollution, is linked to a range of health conditions that can contribute to a significant loss of healthy life years, premature mortality and significant cost to the NHS and wider economy. Recent research estimates that poor housing costs the NHS in England up to £1.4bn per year, with nearly £1bn related to indoor comfort aspects.[3]

What Can Cause the Problem?

Before the onset of large scale energy efficiency improvements, which accelerated from the 1970s onwards, homes benefited from a greater air change rate through the natural leakage of a building. Without this natural air flow, we can experience the unintended consequences of an increase in indoor pollution and a deterioration in indoor air quality. As work is carried out on these existing dwellings to make them more energy efficient, we become more reliant on forced (mechanical) ventilation to replace or supplement natural leakage.

Forced means of ventilation and air exchange will help deliver improved indoor air quality and have a positive impact on personal health and wellbeing. This guide has been developed to enable installers and specifiers to focus on a selection of mechanical means of ventilation.

When To Ventilate – The Contractor and Specifier Responsibility

Existing homes must comply with Building Regulations. Contractors are also advised to refer to the Publicly Available Specification PAS2035, a specification for whole house retrofit. With respect to ventilation, it is the responsibility of contractors and specifiers to ensure the minimum requirements laid down in Approved Document F of the Building Regulations are adhered to.

General guidance can be broken down into three parts:

1. Ventilation requirements when undertaking energy efficiency measures

2. Selecting and installing suitable extract ventilation

3. Commissioning new or upgraded ventilation installations in dwellings

Ventilation in a dwelling is vital for the health and well-being of its occupants. If the performance or fitting of ventilation units or systems in a dwelling do not meet specific requirements and performance standards, levels of indoor air pollutants may rise above safe levels, breaching regulations.

1 National Institute for Health and Welfare. Efficient reduction of indoor exposures. Health benefits from optimizing ventilation, filtration and indoor source controls. 2013.

2 World Health Organisation (WHO). Burden of disease from household air pollution for 2012. 2014

3 Garret *et al* 2021 (BRE): The Cost of Poor Housing

The Risk of Inadequately Ventilating a Home

New Building Regulation ventilation standards were introduced through Approved Document F on 15 June 2022, stating that it is the explicit responsibility of a building contractor, sub-contractor or installer to ensure that all work complies with and meets Building Regulation requirements.

Following the correct procedures is crucial to meeting the latest technical performance standards, which ensure that ventilation in a dwelling is safe and fit for purpose. This work is subject to inspection from a buildings inspector or building control officer.

Short term symptoms of poor IAQ

- Coughing
- Sneezing
- Watery eyes
- Fatigue
- Dizziness
- Headaches
- Wheezing
- Allergic reactions
- Reduced cognitive function

Longer term health effects linked to poor IAQ

- Allergic and asthmatic symptoms
- Respiratory infections and conditions
- Lung cancer
- Chronic obstructive pulmonary disease
- Cardiovascular disease
- Mental wellbeing
- Alzheimer's disease (under investigation)

There are different types and sources of pollution within the home, for example:

- **Moisture** *e.g. from washing, cooking.*
- **Carbon monoxide (CO) and oxides of nitrogen** *e.g. from combustion appliances and smoking.*
- **Volatile organic compounds (VOCs),** *e.g. from aerosols, candles, air fresheners and formaldehyde found in some furniture.*
- *Allergens e.g. from house dust mites.*
- **CO2** *e.g. from humans and also combustion appliances.*
- **Environmental tobacco smoke (ETS).**
- **Odours** *e.g. from cooking, bodies and pets.*

PART 1: VENTILATION REQUIREMENTS WHEN UNDERTAKING ENERGY EFFICIENCY MEASURES

Many existing dwellings are ventilated through natural air flow rather than specific ventilation installations. Therefore, energy efficiency measures carried out on existing dwellings will reduce natural air flow and may cause the dwelling to become under-ventilated and potentially dangerous for occupants. For more information refer to PAS2035 as well as ADF.

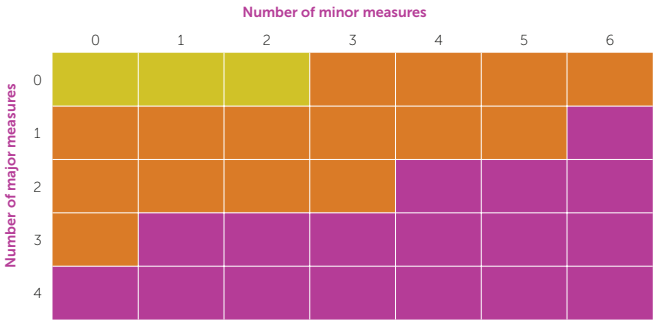
Any building work carried out on an existing dwelling must not reduce the level of ventilation unless it can be demonstrated that the ventilation provision after the work is completed meets the minimum standards of Building Regulations. When carrying out energy efficiency measures to an existing dwelling, an assessment should determine what, if any, additional ventilation provision is needed based on the estimated impact of the work.

When calculating the impact of building work on ventilation, it is important to consider the planned work plus any energy efficiency measures fitted since the original dwelling was constructed to account for the accumulation of measures. Where specific energy efficiency measures are not detailed below, please use the most similar category instead. With the drive to improve energy performance of existing homes it is likely that most homes will fall into Category B and will, therefore, require some form of additional ventilation installed in order to comply with the building regulations. Given the measures date back through the lifetime of the dwelling, it is even possible that many homes will fall into Category C following the introduction major measures such as double glazing or chimney removal alongside minor measures such as loft conversion or the introduction of insulation. In either case, the provision of forced ventilation such as continuous extract fans is advisable.

Overall, use the simple assessment parameters as laid down in PAS2035:

- Is there evidence of condensation and/or mould growth in the home?
- Is there an existing ventilation system, and if yes, is it working?
- Are there sufficient door undercuts (at least 7600mm²) to allow air movement?
- Is there any provision for purge ventilation e.g. window or door openings?

ENERGY EFFICIENCY MEASURE	CATEGORY
Roof insulation:	
• Renewing loft insulation, including effective edge sealing at junctions and penetrations	Minor
• Loft conversions or works that include changing a cold loft (insulation at ceiling level) to a warm loft (insulation at roof level)	Minor
Wall insulation:	
• Installing cavity wall insulation to any external wall	Minor
• Installing external or internal wall insulation to less than or equal to 50% of the external wall area	Minor
• Installing external or internal wall insulation to more than 50% of the external wall area	Major
Replacement of windows and doors:	
• Replacing less than or equal to 30% of the total existing windows or door units	Minor
• Replacing more than 30% of the total existing windows or door units	Major
Draught-proofing (other than openings):	
• Replacing a loft hatch with a sealed/insulated unit	Minor
• Sealing around structural or service penetrations through walls, floors or a ceiling/roof	Minor
• Sealing and/or insulating a suspended ground floor	Major
• Removing chimney or providing another means of sealing over a chimney, internally or externally	Major



CATEGORY A: It is likely that the energy efficiency measures have not reduced the ventilation provision of the dwelling below the requirements, so no further ventilation provision is necessary

CATEGORY B: It is likely that the ventilation provision of the dwelling has been reduced below the requirements, and further ventilation should be provided by either natural ventilation, continuous mechanical extract ventilation or mechanical ventilation with heat recovery

CATEGORY C: It is likely that the ventilation provision of the dwelling has been reduced significantly below the requirements, and further ventilation should be provided by either natural ventilation (by following expert advice for the design, sizing and positioning of ventilators to ensure adequate ventilation provision), continuous mechanical extract ventilation or mechanical ventilation with heat recovery

PART 2: SELECTING AND INSTALLING SUITABLE EXTRACT VENTILATION – THE BASICS

Effective ventilation provides a safe and healthy environment for the occupants of a dwelling by removing excess moisture and indoor air pollutants.

All ventilation work must comply with the relevant requirements of Building Regulations, and this guide sets out requirements for the installation and performance of a mechanical extract fan in a single room in the home.

Selecting an extract fan

There is a wide range of extract fans available, depending on room type and functionality, and it is essential to choose a model that performs to the required standards in order to comply with building regulations and building control inspections. Contractors may preferably consider the optimal and quieter option of continuous extract fans that will provide a steady and low cost lower level of extract airflow to ensure acceptable levels of ventilation are maintained.

Fitting an extract fan

1. All installations of intermittent or continuous extract fans with either manual or automatic control must provide the minimum required extract rate.
2. Flexible ductwork should only be used for final connections, should never exceed 1.5 m in length and should be pulled tight. Duct connections should also be mechanically secured and sealed to prevent leaks.
3. Doors to the room where the fan is located should be adapted to allow sufficient air flow when the door is closed; a door undercut of 10 mm above the final floor covering would be sufficient.
4. The installer should ensure that sufficient fresh air can enter the building (e.g. through trickle ventilators in window frames) to replace the air extracted by the fan. Background ventilators to the outside should be fitted if there is any doubt.
5. The specific fan power for the system should not exceed 0.5 W/l/s 5.
6. The final extract rate from installed fans should be measured to make sure that minimum flow rates are achieved.

NOTE: *This is a summary of some of the critical requirements of the new Building Regulations for ventilation in England. For details of the full regulations, please visit the Government website.*

THE MINIMUM EXTRACT RATES FOR INTERMITTENT EXTRACT FANS ARE AS FOLLOWS:

Kitchens – 60 l/s (or 30 l/s if the extract is a cooker hood)	Bathrooms – 15 l/s
Utility rooms – 30 l/s	Sanitary accommodation (toilets) – 6 l/s

NOTE: *The stated extract rate of a fan may be lower when installed due to resistance from ductwork, grilles etc. It is the installer's responsibility to ensure that the fan can deliver the required extract rate for the room once the installation is complete.*

PART 3: COMMISSIONING NEW OR UPGRADED VENTILATION INSTALLATIONS IN DWELLINGS

Commissioning refers to the process of bringing an installation into operation, ensuring that it is in good and effective working order and that its functionality for the end-user has been tested and verified.

Completing and submitting a commissioning sheet is a legal requirement under updated Building Regulations and enforceable by a local authority building control service or an approved private sector building inspector. If the installer is registered with a recognised competent persons scheme, such as the National Inspection Council for Electrical Installation Contracting NICEIC, they may be able to self-certify some or all of the work being carried out.

The best commissioning process is one that is planned from the start of the project, as this can save time and costs. Here is our quick overview of the required actions for installers:

1. RECORD, MEASURE, CHECK

- ☑ Record the actual equivalent area and location of installed background ventilators
- ☑ Measure and record air flow rates (ventilation system supply and extract terminals and stand-alone extract fans)
- ☑ Check whether background ventilator controls work and that they open, close and operate correctly
- ☑ Check the quality of the installation of the ventilation product to ensure it is correctly mounted within the wall or window aperture
- ☑ Check that any run-on timers are set to at least 15 minutes
- ☑ Check all ductwork and terminals have been installed in accordance with the design criteria and are in good condition with no obvious defects that will affect performance. Check that air flow direction is correct at each room terminal and that there are no abnormal or excessive noises from the ventilation system on start-up, when running in background ventilation mode or when running at a high rate

2. COMPLETE

Complete and sign the required commissioning forms. A downloadable version is available.

3. Provide

Provide copies of all forms to the homeowner within 5 days for new dwellings or within 30 days in all other cases. These must be accompanied by clear and non-technical information so that ventilation systems can be operated effectively; this should include specific instructions on how and when to use the ventilation system, including information on the intended use of available fan settings and advice on when and how the system components should be cleaned and maintained. A full 'Home User Guide' should be provided in addition to the operating and maintenance instructions.

Note: This is a summary of some of the critical requirements of the new building regulations for ventilation in England. For further details on the tests and checks required, please see page 31 of the ***Buildings Regulations*** .

Intermittent Extract Ventilation

In cases where a natural ventilation strategy is suitable, intermittent extract fans within wet rooms and kitchens is a legal requirement. As stated previously, when using a natural ventilation strategy, which relies on air permeability and background ventilation for passive air movement within a dwelling, intermittent extract fans have minimum airflow rates which they must comply to. These are prescribed for most fans, incorporating a range of controls to increase their efficiency through operating time including humidity sensors, PIR (presence detector) and timers.

Whilst considered relatively easy to design and install, they still require careful attention to trickle ventilation specification. Some manufacturers offer installation kits which allow the full solution to be installed internally, reducing the risks associated with external installation, such as the danger of working from height.

There are challenges with using intermittent fans, mainly due to occupant behaviour. There is a risk associated with this ventilation strategy that intermittent fans will be turned off if automatically controlled or won't be turned on if manually operated. This is because they are inherently noisier than modern continuous fans due to operating mode. Occupant education is required to address this risk and ensure users understand the natural ventilation options (opening windows or trickle vents) to purge the dwelling of indoor pollutants.

INSTALLATION TIPS

- Initial commissioning must leave trickle ventilation open
- Ensure a condensate drain is fitted at the bottom of a riser to tile vents
- Check trickle vent sizing requirements
- SELV must be fitted in Zones 1 & 2 where 18th edition Wiring Regulations and RCD protection not applied

APPLICATION TIPS

- Building must not be single sided to lack of cross flow
- Suitable for less air tight homes with a design air permeability higher than $5m^3/(h{\cdot}m^2)$ at 50Pa

Continuous Mechanical Extract Ventilation

Continuous mechanical extract ventilation operates by continually removing stale air from the home, with fresh outdoor air brought in by background ventilation. This could be via a centralised whole-house system or decentralised units in individual rooms.

Centralised mechanical extract ventilation (cMEV) consists of a fan installed in a central location, such as a loft or utility cupboard, ducted to kitchen and wet rooms within the dwelling. This provides a whole-house system for removing pollutants, allergens, viruses and moisture. As this is a ducted system, care needs to be taken during the design stage to ensure minimum pressure drops and other requirements are met for the system to operate efficiency and quietly. This design must be clearly followed during the installation phase to ensure the design and as-built details align, reducing the potential for a performance gap.

Decentralised mechanical extract ventilation (dMEV) works on a room-by-room basis, compared to cMEV which services the whole house. This means the dMEV solution is best suited to retrofit installations. These individual units run continuously and provide an effective low cost method for extracting stale or high moisture air from the individual rooms they service. dMEV systems are often designed within bathrooms, kitchens, utility rooms or other wet rooms.

INSTALLATION TIPS

- In all cases, limit the use of flexible ducting as this impacts air flow
- Ensure balanced air flow across the system
- Avoid unheated spaces where possible
- Insulate ductwork in unheated spaces (e.g. loft) in accordance with SAP requirements
- For central systems, follow duct size recommended in the design to reduce turbulence and noise

APPLICATION TIPS

- Suitable for any home regardless of air permeability levels
- Decentralised system are ideal where there is limited space for the central unit or the potential for complicated ductwork channels

Mechanical Ventilation with Heat Recovery

Mechanical ventilation with heat recovery (MVHR) is an energy efficient supply and extract ventilation system. Whilst extracting stale indoor air, it recovers heat which would have otherwise been lost outside. This heat is transferred to the supply of fresh filtered air coming into the dwelling, which reduces the demand on the central heating system and wastes less paid for heat. MVHR can be a centralised, whole-house system, placed within the heated envelope, or as single room ventilation with heat recovery (SRVHR).

Regardless of whether the system is centralised or decentralised, MVHR can offer many benefits:

- Absolute assurance of necessary ventilation rates to sustain critical indoor air quality (IAQ) levels over the lifetime of the home
- A de-risk technology that can operate effectively down to zero infiltration, reducing any IAQ risks presented if air tightness standards overshoot design performance
- Modern systems now provide world leading efficiency performance due to Energy Related Products policy and 'a race to the top' via SAP Appendix Q

Modern systems are now sited in the heated envelope and have light displays to signal when filters require changing. Once switched on and commissioned there is minimal consumer intervention required, save for a filter change every year and maintenance on a five-year basis. The specification of controls can also improve overall system energy performance, which make it possible to reduce ventilation rates during unoccupied periods to improve energy efficiency.

INSTALLATION TIPS

- In all cases, limit the use of flexible ducting as this impacts air flow
- Insulate ductwork in unheated spaces (e.g. loft)
- For central systems, follow duct size recommended in the design to reduce turbulence and noise

APPLICATION TIPS

- Suitable for homes with a design air permeability lower than 5m^3 /(h·m^2) at 50Pa
- SRVHR an option for specific space limited circumstances or the potential for complicated ductwork channels
- SRVHR is an easier option than central systems for retrofit solutions
- Recuperative cell SRVHR enables ventilation through the façade of the home with no need for complex ductwork and use built in sensors to automatically measure how much fresh air needs to be supplied and pre-heated
- Regenerative cells are compact 'through the wall' fans which ventilate with high air volumes and protect against cooling and strong wind pressure

Positive Input Ventilation (PIV)

PIV systems are a simple retrofit ventilation solution that works by continually diluting, displacing, and replacing indoor air with filtered, lower moisture content external air. They can be positioned in the loft, or as wall hung units. A properly designed and installed PIV system will effectively mix the indoor air with external air throughout a dwelling and gently change the air in a home on a controlled and continuous basis. The continuously diluted internal air has a resulting lower moisture content and therefore dew point, and the whole dwelling ventilation rate it provides, which should be calculated in a way consistent with all other ventilation systems, also helps control other non-moisture related indoor air pollutants.

Air will naturally move from areas of high vapour pressure to low vapour pressure and PIV systems are designed to take advantage of this natural phenomenon, not work against it. When moisture laden air leaves a wet room, via open doors or door undercuts, it will mix with the drier air being delivered centrally to the dwelling by the PIV unit, have its moisture content reduced by dilution and drive down the average dew point of the air within the dwelling.

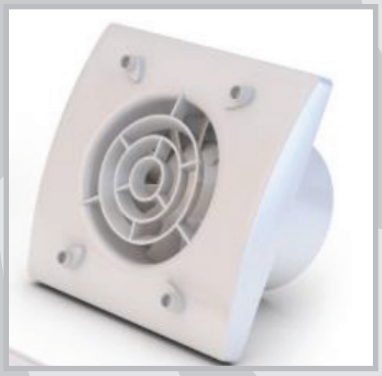
The installation of a PIV unit on its own, with or without Background Ventilators, is not always sufficient to provide effective ventilation in a dwelling. Depending on the layout of the dwelling, there may be a need for PIV system enhancement extract fans to be installed in some wet rooms as well to optimise performance and provide adequate ventilation.

INSTALLATION TIPS

- In all cases, limit the use of flexible ducting as this impacts air flow
- Insulate ductwork in unheated spaces (e.g. loft)
- Consider use of enhancement extract fans in any wet rooms where there is no openable window to the outside, where the wet room leads to a habitable room or where air from the PIV unit would have to pass through another wet room
- PIV systems require the same "Purge Ventilation" measures as all other ventilation systems. Like all other systems we also understand that appropriate internal air transfer measures such as sufficient undercuts below internal doors are essential
- Careful design and planning is required to optimise configuration
- If using an air source or wall hung unit, situate the intake and duct to the non-road side of the building

APPLICATION TIPS

- Suitable for homes with any air permeability but requiring a whole house solution
- Suitable for areas where there are noise of pollution concerns
- Ideal for situations where it is possible to benefit from recovering the heat from solar gain



How Do I Improve My Ventilation Competency

Most BEAMA Ventilation manufacturing members offer training courses for contractors. The course is written and accredited by NICEIC and is designed to ensure contractors are equipped with the latest regulatory requirements along with a knowledge of the critical design and installation characteristics of a range of ventilation systems.

TO BOOK A COURSE, CONTACT A BEAMA VENTILATION MEMBER TODAY!

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