PCA
Property Care
ASSOCIATION

Guidance Document:

Surveying of Ventilation Systems in Existing Residential Dwellings

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CONTENTS

1. INTRODUCTION

The purpose of this document is to provide property surveyors and building practitioners with a guide to the requirements for carrying out an effective survey to determine ventilation related issues. This guide is written specifically with existing UK housing stock in mind, principally (but not exclusively) properties built between 1900 and 2010. The focus is on evaluation and diagnosis of ventilation related moisture problems. Specification of solutions is not covered within its scope, however will be covered in other PCA technical documents and guidance notes.

With the increasing drive to make our existing housing stock more energy efficient, we are eliminating natural ventilation into our houses. Whilst this improves the property's ability to retain heat, lack of ventilation leads to stale air and associated problems. It is therefore essential that we maintain a fresh supply of air. The requirements in Building Regulations Approved Document F have made strides in reducing the problem in modern housing stock. However, houses that predate this document, which make up the vast majority of the UK housing stock, may have inadequate ventilation. Ultimately this places greater emphasis on the need for mechanical ventilation. This document is designed to outline a methodology for how to determine if the ventilation within an existing dwelling is sufficient.

In theory properties built after 2010 should comply with the Building Regulations and be provided with adequate means of ventilation. The reality is that there is very little enforcement of the regulations and problems in properties since this date may arise.

This document looks solely at domestic dwellings. For commissioning and provision of non-domestic ventilation systems the procedure approved by the secretary of state in CIBSE Code M should be followed.

What is ventilation?

Approved Document F states that "ventilation is simply the removal of 'stale' indoor air from a building and its replacement with 'fresh' outside air". It is required for: -

- Supplying air for breathing
- Dilution and removal of airborne pollutants
- Control humidity
- Air for fuel burning appliances
- Temperature control

Failure to adequately ventilate a property properly can result in indoor air quality issues, condensation and mould growth. On the other hand too much ventilation may result in heat loss and reduced energy efficiency. Whilst appropriate ventilation will assist with the control of many of the components that contribute to poor indoor air quality, this document focuses on control of humidity within the existing UK housing stock.

Types of ventilation

Within a property there are essentially two main types of ventilation. Firstly, infiltration or background ventilation, which is the uncontrolled air exchange between outside and inside. All houses will have some degree of infiltration.

Secondly, controlled or purpose provided ventilation e.g. extractor fans and trickle vents. Approved Document F sets out three strategies to comply; extract ventilation, whole building ventilation and purge ventilation.

It then details four systems which comply with this strategy:-

System 1: Background ventilators and intermittent extract fans
System 2: Passive Stack Ventilation (PSV)
System 3: Continuous mechanical extract
System 4: Continuous mechanical supply and extract ventilation with heat recovery (MVHR)

In addition, alternative strategies of ventilation may include Positive Input Ventilation (PIV) systems.
Despite numerous systems available, in the vast majority of instances if a ventilation system is fitted it is likely to comply with System 1, (background ventilators and intermittent extractor fans). Therefore, in the main this document looks at properties where there is either no existing mechanical ventilation or a System 1 type fan. In addition, this document does not look at properties which have been designed with natural ventilation systems. Guidance on naturally ventilated properties can be found in BS 5925.

Principle of Ventilation
Condensation and mould growth problems typically indicate that heating, ventilation and moisture production are out of balance. One of the key objectives of the surveyor is to determine which of these is out of balance. In many instances, adjustments to heating and ventilation are easier than moisture production if there is no obvious excessive source of moisture.

Although prolonged monitoring of the property will help build the best picture of the internal atmospheric conditions, in reality extensive observation periods are undesirable. This document focuses on the process of a single site visit and how a surveyor can make best use of a limited amount of time on site.

Approved Document F introduces the principle that it is important to minimise uncontrollable infiltration and supply sufficient purpose provided ventilation. This way reasonable indoor air quality can be maintained whilst avoiding energy waste. During the inspection, the surveyor should identify areas of uncontrolled infiltration. Naturally, some historic buildings will have greater amounts of uncontrolled infiltration and special consideration may be required.

The provisions set out in Approved Document F are based on winter conditions and that supplementary purge ventilation, i.e. opening of windows may be required during summer months.

2. DEFINITIONS

For the purposes of this document, the definitions in BS 6100: Part 5 and Building Regulations Approved Document F apply with the following amendments/additions:

Background Ventilator
A small ventilation opening designed to provide controllable whole building ventilation e.g. a window mounted trickle ventilator.
Background Ventilation
Term often used as an alternative to “whole building ventilation” and/or a term used to describe the continual low duty setting of a dMEV, MEV or MVHR system.
BCB or Building Control Body
A local authority or an approved inspector.
Condensate
Liquid water produced by condensation.

Condensation
Process whereby water is deposited from air containing water vapour when its temperature drops to or below dewpoint.
Dewpoint
Temperature at which 100% relative humidity is reached and air becomes saturated with water vapour.
dMEV Fan
A continuously operating "wet room" extract fan which operates at a low background rate with an occasional boost facility. These fans generally operate at much lower airflow rates than intermittent extract fans and the pressures they need to develop to overcome ductwork systems are therefore much less. Consequently, they are significantly quieter in operation, with many operating at imperceptible noise levels.
Ductwork System
An assortment of components used to transfer air into and out of a building. These include rigid, semi-rigid, flexible, insulated and un-insulated lengths of ductwork, bends, t-pieces, connectors etc.
Extract ventilation
The removal of air from a room or space to outside. This may be achieved via passive stack ventilation or mechanical ventilation.
Infiltration
The uncontrolled exchange of air between inside and outside of a building through cracks and other unintentional openings caused by wind pressure and/or the stack effect.
Intermittent Extract Fan
An extract fan designed for occasional use to complement the whole building ventilation, typically provided by background ventilators e.g. trickle ventilators. Careful consideration needs to be given to the ductwork system attached to these fans due to the high-pressure drops associated with the high flow rates they provide. These fans should not be fitted in a home unless there are sufficient background ventilators installed, and the designer can be certain they will be used appropriately.
MEV unit
A centrally mounted, continuous mechanical extract ventilation system which is typically connected to a number of "wet rooms" via a system of ductwork and discharges air to atmosphere via a single external terminal.
MVHR – Mechanical Ventilation with Heat Recovery
A whole home mechanical ventilation system with heat recovery. Designed to work continuously by extracting air from "wet rooms" and supplying air to the "habitable rooms" of a property. A proportion of the heat from the extract air is transferred to the supply air via a heat exchanger. These systems negate the need for purpose provided background ventilation e.g. trickle ventilators.
Natural Ventilation
Ventilation of a structure by natural means without the use of mechanical system.
PIV – Positive Input Ventilation
A ventilation system which supplies filtered ventilation air from outside to a property, usually via the central hallway or above the stairwell.
PSV – Passive Stack Ventilation
A ventilation system using ducts from terminals in the ceiling of rooms to terminals on the roof which extract air to the outside by a combination of the natural stack effect and pressure effects of wind passing over the roof of the building.
Relative humidity
The amount of water vapour contained within a given volume of air compared with the maximum amount that could be contained at the same temperature (usually expressed as %RH).

SRHRV – Single room heat recovery ventilation
A single room mechanical ventilation system with heat recovery. Designed to work by simultaneously supplying and extracting air in "wet rooms". A proportion of the heat from the extract air is transferred to the supply air via a heat exchanger. These systems only negate the need for purpose provided background ventilation e.g. trickle ventilators in the rooms they serve.

Thermal bridge
Part of a construction with thermal resistance significantly lower than that of the surrounding construction e.g. a window lintel.

Vapour
Substance in its gaseous phase.

3. SURVEYING INSTRUMENTS

Without question the best tools for surveying are common sense and the surveyors own experience. They must have a good working knowledge of all types of building construction. Surveyors should be able to demonstrate that they have acquired a certain standard of experience and competence. One such standard of training and competence that is recognised is the level achieved by passing the Certificated Surveyor in Remedial Treatment (CSRT) or Certificated Surveyor of Timber and Dampness in Buildings (CSTDB) examinations, or the BPEC in domestic ventilation.

However, as a minimum the surveyor should be armed with the equipment detailed in the PCA Code of Practice for the investigation and provision of ventilation in existing dwellings. This list includes;

- portable ladder (with safety provision for peripatetic working)
- torch
- moisture meter
- digital camera and notebook

In addition to this, more specialist equipment should be available to the surveyor. The following section looks in greater detail at some of the more specialist tools at the surveyor's disposal;

Fig 1. Selection of some of the tools a surveyor should have at their disposal, such as hygrometer, moisture meter and surface thermometer

Thermometer – Surface & Ambient
The surveyor must be able to establish temperature differentials within the building envelope. A surface thermometer will allow the surveyor to check for variations in the temperature of the building envelope that may be prone to condensation and mould. This may help the surveyor identify underlying defects such as cold bridges.

In addition, the surveyor will need means to determine the ambient temperature. This plays a fundamental role in internal atmospheric conditions and determining vapour pressure.

Anemometers

Anemometers are essential for determining the efficiency of an existing ventilation system and for commissioning any new systems. The various methods of testing ventilation systems are covered in the existing ventilation section. The use of the more accurate powered hood type anemometer is always recommended. If the surveyor is using a standard vane anemometer it is essential that the surveyor understands that conversion factors are essential to provide an accurate reading.

Any equipment used to commission a ventilation system must be calibrated by an appropriate body and conducted by a person registered with an applicable competent persons scheme.

Electronic Moisture Meter

Whilst the electronic moisture meter has limitations it can still provide a very useful guide and diagnostic tool. This piece of equipment can prove very useful to assist in differentiating between condensation and other forms of dampness. Further details on the use of electronic moisture meters can be found in the PCA technical document - The use of Moisture Meters to establish the presence of Rising Damp.

Hygrometer

An instrument used for measuring relative humidity. Most modern hygrometers will typically provide additional information such as ambient temperature and dew point temperature. This information is essential for establishing the atmospheric conditions within the building.

Data loggers

It is rare that the surveyor will get to carry out a survey at optimum times, which is typically during the early hours when the external temperature is at its lowest. Whilst a lot of information can be gained during the initial inspection and through occupier engagement, observation over extended periods may be required to help diagnose and substantiate expected problems. Data loggers give the opportunity to look beyond the 'snap shot' environmental conditions at the time of the survey.

It is recommended that in addition to the internal loggers, an external logger is placed in a position unaffected by direct sunlight so that the data provided can be used to determine vapour pressure differential (excess) between the inside and outside of the property. This can help provide an indication in winter months of moisture production versus ventilation.

NOTE: It is essential that all electronic measuring instruments such as thermo-hygrometers are allowed time to reach equilibrium with their surroundings before readings are taken.

4. SURVEY

Like all surveys, visual assessment should make up the preliminary investigation. This should include both external and internal checks.

A survey will only provide a 'snap shot' glance of the conditions at the time of the survey. Whilst this may help provide much of the preliminary information required to help build up a picture of the problem, for more complex issues continued monitoring may be required.

Historic buildings

Special considerations may apply to historic and traditional buildings which are listed, or in a conservation area. Guidance by English Heritage and in BS 7913 Principles of the Conservation of Historic Buildings should be followed.

NOTE: For listed buildings you may require permission from the relevant local authority conservation officer to carry out certain ventilation installations or upgrade works, such as forming core holes for extractor fans.

Buildings included in the schedule of monuments maintained under section 1 of the Ancient Monuments and Archaeological Areas Act 1979 are exempt from compliance with the building regulations.

External observations

Whilst condensation is often considered to be an internal problem, an inspection of the external structure is fundamental to any survey. Any external defect which will lead to internal dampness or reduce the thermal properties of the structure should be identified by the surveyor and included in their report.

During the external checks the orientation should be established, as this may assist with diagnosis and help identify problematic areas during the internal inspection. For example, a colder north facing elevation may be more prone to condensation and mould growth, whilst south and westerly elevations may be more prone to wind driven rain.

During the external inspection it is vital to identify variations in construction which may result in areas of different thermal properties. For example, outriggers on Victorian terrace properties are frequently constructed of 4.5 inch (112mm) single skin brick work. In some instances, it may be possible to determine solid floor construction between floors during the external observations. This may help assist in identifying possible cold bridges.

The external checks should also be used to determine any external defects that may be contributing to moisture e.g. defective rainwater goods or pointing. Where defects are identified, an inspection of the corresponding internal wall will be required and where there is risk of any timber decay, then the surveyor should act in accordance with the PCA Code of Practice for the Identification and Control of Dampness in Buildings.

On approaching the building, note if the windows are opened. It is not uncommon for occupants to increase purge ventilation in anticipation of a survey. This will heavily impact the internal conditions at the time of the survey and impede 'snap shot' diagnostics.

Fig 2. Another example of discontinuous insulation which will result in temperature differentials in the structure and may result in condensation and mould growth problems.

The surveyor should check the external ground levels to all external elevations of the building and a note should be made of ground height which is not sufficiently below the finished floor level of the building. Even if the ground level is below the finished floor level, rainwater splashback may impact the thermal properties of that wall. (Building Regulations require 150mm clearance below dpc or internal floor level). Even when measures have been installed to control lateral water penetration as a result of high ground level this may affect the thermal properties of that wall.

The type of glazing may impact the thermal performance of the property. Single glazed windows tend to have particularly poor “u” values and will always be prone to condensation. Improvements to the glazing should never be looked at in isolation and ensuring adequate ventilation is provided is essential to avoid mould growth and condensation problems.

Roof structures should be noted and any areas of flat roofs identified. These areas typically have lower thermal properties than pitched roofs and should be checked. Low eaves should also be identified as these areas typically have sloping ceilings internally which are not insulated and can be prone to dampness problems, as shown in Fig 5.

Fig 3. External wall insulation applied to a solid wall structure. Note the breaks in continuity of the insulation firstly where the fence intersects the insulation and secondly at the base of the wall, where the insulation has not been continued to ground level.

Outlets for any existing ventilation system should be identified during the external observations. The surveyor should ensure there are no blockages to the grilles which may hinder the performance of the system e.g. vegetation growth. External grilles should be clear of obstructions to allow a free flow of air and ensure that the “free area” of the terminal grille is a minimum of 90 percent of the free area of the ducting being used. This also applies for other moisture producing appliances such as tumble driers.

Retrofit insulation

Traditional solid wall construction will be more susceptible to rainwater penetration. However, retrofit cavity wall insulation can act as a medium to allow water to track across the cavity resulting in dampness of the interior wall. If the surveyor suspects rainwater penetration on a cavity wall then inspection of the cavity will be required, either by a borescope or by the removal of a brick. If upon inspection of the cavity the insulation is dry then the issues are probably the result of the internal environment.

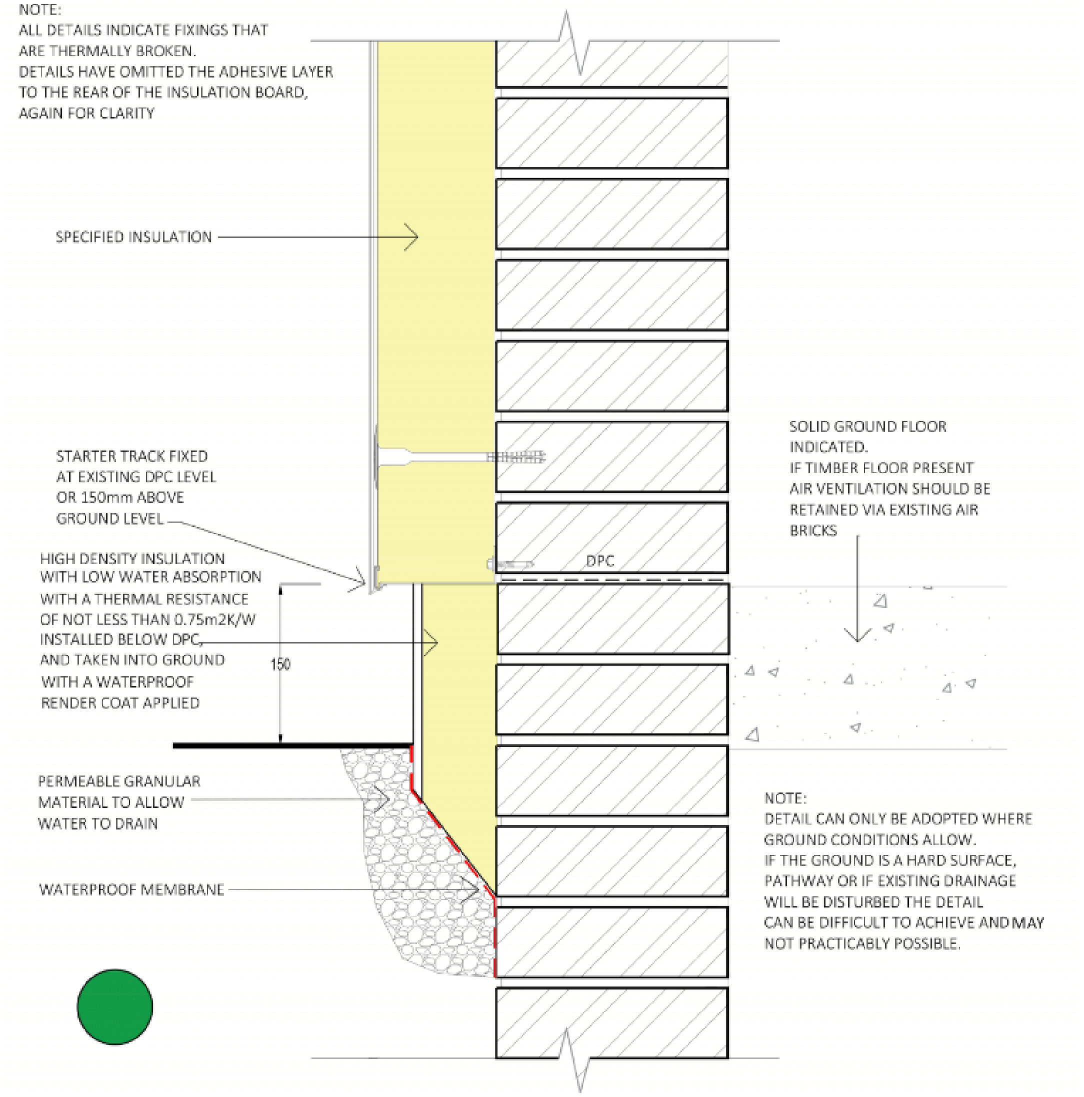

Fig 4. CAD drawing taken from documents that supplement the new PAS2030:2017 provided by SWIGA that illustrates best practice for external wall insulation at the base of a wall.

Any retrofit insulation measures should be noted during the external checks. Whilst the insulation helps to regulate internal temperature, the surveyor should be ensuring that the insulation is continuous and that no cold bridges have been formed as a result of discontinuity in the insulation. These are typically found around windows or at the base of walls where the insulation has been terminated above the level of the damp proof course.

Where possible and applicable the cavity should be checked for debris. This may not only act as a possible bridge to allow moisture to bypass the damp proof course but may also act as a thermal bridge creating a colder spot which will be more prone to condensation and mould growth.

The photo opposite shows a number of areas of discontinuity of the external wall insulation. Firstly, where the insulation has been cut around the fence but also where the insulation has been terminated above the ground level.

Other potential cold bridges should be noted, for example, concrete lintels above windows and doors. Notes of these areas should be made on the site notes and checked internally for temperature differentials.

Fig 5. Mould growth to the uninsulated eave section of the roof.

Internal observations

As in the external inspection, visual assessment will form the backbone of the internal checks but should be complemented by the use of a surface thermometer, hygrometer and electronic moisture meter. Any areas of visible evidence of condensation and mould should be noted. In almost all instances the first sign of imbalance within the indoor environment is mould growth and condensation. Identification of mould species is normally of very little benefit and provides little diagnostic information, however its presence *would* indicate that the internal environment is out of balance. The surveyor must be able to identify moisture resulting from high atmospheric moisture and other forms of dampness. The following section briefly highlights some of the key diagnostic features which will assist in determining a condensation problem from that of moisture from other sources.

Rising damp

- No mould growth
- Tide mark – typically up to 1m high
- Presence of salts
- Base of the wall
- Remains unchanged over long periods

Rainwater Penetration

- Signs of external defect
- Varying height
- Can be very wet conditions
- Will be influenced by external weather

Plumbing defect

- Possible mould growth
- Can be very wet conditions
- May be similar to rainwater penetration but not weather dependent

Condensation

- Mould growth
- No salts
- Water beading on the surface
- Corners, high and low level, behind furniture items
- Seasonal
- Run Marks
- Samples from within the wall will not be damp if surface condensation is the sole cause

Areas of visible dampness or mould growth should be noted and these areas checked for significant temperature differentials. This can be done with a surface thermometer or a thermal imagining camera. This may help to identify underlying defects such as voids in insulation or bridged cavities.

One of the key objectives of the internal inspection is to determine any cold bridges. In addition, many cold bridges may not be evident externally e.g. plasterboard adhesive used to "Dot and Dab" plasterboard. A surface thermometer should be used to determine any variations in temperature and any large discrepancies noted. The internal wall finishes should be noted. BRE Digest 297 states *"In dwellings which have a highly responsive structure, such as dry lined walls, problems may be encountered once the heating is turned off and the surface temperature falls quickly*".

In addition, "*In high thermal capacity construction, such as plastered solid brick walls, condensation may occur when moisture generation is increased at the same time as heating is switched on.*" For example if the heating is set to the same time as occupants are showering in the morning.

The surveyor should take note of the number of existing "wet rooms", and other sources of moisture production should be identified such as tumble driers, particularly the non-ducted condenser type. Particular attention should be paid to existing ventilation in the wet rooms.

Heating

The heating system can play a significant role in dampness problems and should be able to "*maintain air and surface temperatures sufficiently to prevent problems associated with excessive humidity*" as described in BS 5250. A modest but constant background heat is preferable to intermittent heating since this will help to maintain a higher ambient temperature in the fabric of the building. The surveyor should take note of the type of system, and location of heating elements. During a 'snap shot' survey it may be difficult to determine problematic heating regimes, whilst long term monitoring will provide a better picture of the heating regime. Below are highlighted common problems with specific heating types.

Portable Gas heaters – whilst the heat emitted from this type of heater will increase temperature and reduce relative humidity, this is normally offset by the volume of water they produce in the combustion process. Also, they heat air rather than the building fabric, resulting in fluctuations in temperature.

Warm air heating – due to its ability to heat air rapidly it has a tendency to be used intermittently resulting in fluctuations in temperature.

Intermittent electronic storage heaters – considered expensive to run and difficult to control. In many instances used intermittently like warm air heating.

It is worth noting that "*many condensation problems arise because the majority of buildings are not used 24 hours a day of the year and are, therefore, not heated continuously*." (BS 5250). Heating the air alone is unlikely to be a satisfactory solution, not only on grounds of cost, but also of practicality. Unless cold surfaces are eliminated, condensation at some point is inevitable. Any remedial action, therefore, must involve both a lowering of moisture levels and the elimination of cold surfaces.

Undercuts to doors

As previously stated, in the vast majority of properties any existing ventilation system is likely to be a system 1 intermittent fan, and almost always located in either the kitchen and/or bathroom. However, it is vital that there is adequate air movement throughout the property and for this reason it is essential to ensure that there are sufficient undercuts to doors.

Approved Document F states that to ensure good transfer of air throughout the dwelling, there should be 10mm undercut below a standard 760mm door. Whilst in Approved Document F this applies to type 3 systems, it should be good practice to ensure this is applicable for all systems where the rooms are not individually ventilated, such as by MVHR. If the property has no floor covering then a 20mm undercut should be provided.

Basements

Basements by their very nature will have reduced rates of air exchange and in basements which are habitable, greater emphasis is placed on the need for the provision of adequate ventilation. For properties with a basement with a large permanent opening it should be classed as part of the whole dwelling. However, properties with an isolated basement may require special consideration and may need to be considered a separate entity to the remainder of the property.

Further guidance on distinguishing between atmospheric moisture and ground water issues in basement can be found in the PCA Code of Practice for Waterproofing of Existing Underground Structures. And the discussion paper Considering Ventilation and Air Management in Basements as part of an Overall Waterproofing Strategy.

Roof voids

Any loft voids should be inspected to ensure they are sufficiently insulated and that any insulation is continuous. Any breaks or voids in the insulation will create variations in temperature which may result in condensation and mould growth problems. Others areas where air may re-enter the loft include around spotlights and loft hatches. It should also be checked that insulation should not block eave ventilation which may result in condensation within the loft void.

Special consideration should be given to the loft void if PIV units are present to ensure there are no cracks within the ceiling and that there is sufficient airflow in the loft. Further details on PIV can be found in the PCA best practice guidance "Positive Input Ventilation". Layout may also be an important consideration where PIV units have been installed and where remote rooms may require supplementary ventilation.

Relative Humidity

Relative humidity is one of the key factors in mould growth and provides a good indicator of the environmental conditions. The concepts of Relative Humidity and Dew Point have been described in the PCA Code of Practice for the Investigation and Provision of Ventilation in Buildings.

With the aid of a surface thermometer and hygrometer to measure wall temperature and relative humidity within a room, it is a comparatively simple matter to establish whether the surface temperature is at, or below, the Dew Point, and this will help determine where condensation is possible. Due to restricted airflow in corners and behind furniture these areas are typically cooler and would be a logical first place to take surface temperature readings. Taking readings from the centre of the wall will not necessarily be representative of these areas. Some thermal imaging cameras once connected to a hygrometer will also illustrate areas which are below dew point.

The method described above will help to determine if condensation is occurring at the time of the survey. We have already established that it is rare that the surveyor is on site at the optimum time, however, the dew point temperature does not need to be achieved for mould growth. If the relative humidity is sufficiently high for prolonged periods then mould growth can occur. The table below is taken from Approved Document F and indicates the relative humidity criteria required for mould growth to occur and clearly emphasises that mould growth can occur well below 100 percent relative humidity. This table also highlights the significance of time in the potential for mould growth. With this in mind data logging and checking for periods that match the criteria set out in the table below could be hugely beneficial as a diagnostic tool.

Table A2 Indoor air relative humidity	
Moving average period	**Room air relative humidity**
1 month	65%
1 week	75%
1 day	85%

Care should be taken when using relative humidity in isolation as variation may be a result of varying temperature and not an increase in moisture.

Vapour pressure and moisture production

Unlike relative humidity, vapour pressure represents a quantifiable amount of moisture, not a proportion, and can be used to determine levels of moisture production in relation to ventilation. This can be determined by establishing the internal relative humidity and temperature and using a psychrometric chart to determine the vapour pressure. This exercise is repeated with external relative humidity and temperature.

Subtracting the external vapour pressure from the internal will provide a vapour pressure differential. Due to moisture production created by human activity in winter months within the built environment e.g. showering, cooking etc, moisture levels within the indoor environment are normally higher then external.

Average vapour pressure differentials of 0.45kpa (kilopascal) might be acceptable, although other data may be required to build up a more detailed picture. Below 0.45kpa would typically be considered “dry” or acceptable where ventilation balances moisture production. Above this level would be considered “wet occupancy.”

The use of this method is best used in conjunction with long term data monitoring as figures can fluctuated dramatically with purge ventilation such as opening of windows.

5. OCCUPANTS AND MOISTURE PRODUCTION

As previously detailed, there is a wealth of tools at the disposal of a surveyor to help assist with a diagnosis of moisture problems within dwellings. However, much can be learnt from occupier engagement.

Occupier engagement may prove particularly useful when long term monitoring is not a viable option. Whilst the information may not be as reliable as data gathered over a longer period it may help to determine:-

- Heating regime
- Occupancy numbers
- Age
- Family economics
- Types of appliances
- Sources of moisture
- Service and maintenance history of any existing ventilation system

Occupier engagement also provides a opportunity to establish if any existing ventilation system is being utilised correctly or rationale for why the system isn't being used e.g. noise or economics. Increase in fuel cost may encourage intermittent heating patterns which are favourable to condensation and mould growth.

Rainwater penetration, rising damp or water below a suspended timber floor will all produce very limited moisture in comparison to human activity and whilst these issues should always be addressed they are unlikely to be significant contributing factor to a condensation problem in the internal environment.

6. EXISTING VENTILATION

As domestic dwellings have become increasingly air tight, greater emphasis has been placed on the requirement for mechanical ventilation. Existing ventilation within a property can take many forms as previously detailed, although in the vast majority of UK properties it is likely to be a Type 1 system if ventilation has been fitted at all.

It is prudent for the surveyor to check that the system has not been altered in a way to prevent it from working to its full capacity. Occupants may restrict the ventilation system on the understanding that it is affecting the heating. This is particularly the case with intermittent fans.

The location and height of the fan may also impact the efficiency of the unit. Units placed at low level may have a reduced performance, for example, where a mono pitched ceiling is present in a Victorian outrigger bathroom.

Approved Document F also says that Type 1 and 3 ventilation systems *"should be designed to extract moist air as close as possible to the point of generation and to the outside, preferably away from prevailing wind"*

Fig 6. An example of an intermittent fan which had been covered by the occupant. In many instances the alterations may not be so obvious.

NOTE: Buildings with exceptionally high vapour load such as swimming pools will require special consideration ventilation solutions and fall outside the scope of this document.

Fig 7. The picture above shows a trickle vent which was stuck to the window frame but without sufficient opening.

Trickle Vents

It is a popular misconception that trickle vents are fitted as a form of ventilation on their own, this is incorrect. The purpose of trickle vents is to provide the make up air from around the property to ensure that the fitted extractor fans work as efficiently as possible. Intermittent extractor fans (System 1) rely heavily on trickle vents being fitted correctly and more importantly being open.

It is deemed good practice to have trickle vents fitted in all instances. Where applicable, note should be made of any existing trickle vents. Exceptions are wet rooms which should have separate means of ventilation. It is recommended that trickle vents have an area equivalent to 2500mm^2. The surveyor should also check to ensure the trickle vent is not oversized.

It is also prudent where possible to remove the air vents to ensure they have been fitted correctly and allow a free flow of air. The picture attached shows trickle vents that have not been correctly fitted. Ideally trickle vents should be placed at 1.7m above floor level to avoid uncomfortable cold drafts.

Fig 8. Unconditional method of testing a type 1 ventilation system using a powered hood.

Testing of existing ventilation

Essentially there are three methods for testing the performance / air flow rate of mechanical ventilation systems set out in Approved Document F;

A. Unconditional
B. Conditional
C. Minimum bench mark

Unconditional Method (Method A)

The simplest and easiest of the three methods but requires the use of a powered flow hood. This eliminates the need for configuration of the data after testing. The powered hood is able to measure air flow without the influence of back pressure or other restrictions and as a result this is considered the preferred method of testing.

Conditional Method (Method B)

The traditional method which is referred to as the conditional method, requires correction factors to be used to calculate the actual airflow rate. This method of testing requires the use of a vane anemometer, or other similar testing equipment.

A universal calculation is used to determine the airflow rate, which is dependent on figures provided by the manufacturer. "*The conversion factors must be provided by the fan manufacturer and be based on third party testing by a UKAS accredited body." - NHBC Building Control.* These figures are not always easily obtainable on site during the course of a survey.

The Building Services Research and Information Association (BSRIA) recommend that the minimum vane diameter for a vane anemometer is 100mm.

Fig 9. Conditional method of testing using a vane anemometer

The minimum Bench Mark Method (Method C)

Used for System 1 fans where no data is provided to be able to use Method B, but less accurate than the other methods detailed. Requires the use of a vane anemometer like method B and the fan is expected to achieve the reading highlighted in the table below which also factors in performance degradation.

Fan rating	Benchmark Performance
15l/s (bathroom)	12 l/s
30l/s (Utility)	24 l/s
60l/s (kitchen)	35 l/s

In most instances we would advise against using these minimum benchmark performance figures to determine acceptable levels of ventilation are being provided due to the lack of accuracy. Whilst this method isn't ideal it may prove some indication on the efficiency of an existing ventilation system.

Since the release of Approved Document F, the National House Building Council (NHBC) have issued a guidance note stating *"the procedure for testing System 1 axial fixed fans using a vane anemometer has presented practical challenges. In particular, it has been shown that the resistance of the vane anemometer can adversely affect the test results, to the extent that a compliant fan may appear not to meet the recommended extract ventilation rates in Table 5.1a of Approved Document F."*

NOTE: when using any of these testing methods, all background ventilators should be opened and all doors and windows shut.

Suggested Acceptable Levels of Air Flow

Whilst the figure set out in Approved Document F set out a minimum requirement, it provides a good benchmark for minimum standards in existing dwellings. Approved Document F states adequate ventilation so use these levels;

Intermittent levels – System 1

- 30l/s adjacent to hob; or 60l/s elsewhere in kitchen
- 15ls bathroom
- Utility 30l/s
- Cloakroom 6l/s

Continuous – System 3

- 13l/s adjacent to hob
- Utility 8 l/s
- Bathroom 8l/s
- Cloakroom 6l/s

If the property was constructed post 2010 it should be possible to check if all the necessary documentation has been completed during commission. This information may be obtainable during the occupant engagement.

MVHR (Mechanical Ventilation with Heat Recovery)

Increasing drive to make buildings more energy efficient has seen an increase in the popularity of MVHR systems. These systems are very difficult to retrofit and will typically only be found in more recently constructed dwellings. These systems are dependent on continual ongoing maintenance particularly filter changes and ensuring they have been maintained would be a logical place to start if any defects should occur. It would also be prudent to check that the system has been installed and commissioned correctly in accordance with Approved Document F.

These systems can include large volumes of ducting and the surveyor should check that appropriate ducting has been used. Guidance on ducting is covered in section 7 of this document.

Oven hoods

Assessment of oven hoods can prove problematic. Many oven hoods are recirculating and do not provide means of ventilation. Those that are being used for ventilation for the purposes of Approved Document F should have a capacity of 60l/s. However, a lack of ongoing maintenance and filter changes will significantly reduce their performance. In many instances testing the oven hood is not possible internally and the system may have to be tested from the external side.

If it has been determined that the fan does not have the output expected the surveyor should look for possible causes. In most instances inappropriate ducting or a lack of maintenance are probable causes. However most manufacturers provide online trouble shooting guidance for other possible issues which may help improve the efficiency of the ventilation system.

From a ventilation perspective oven hoods should be regarded as a means of purge ventilation and at best an intermittent extractor fan and therefore the rules of system 1 fans would apply.

7. DUCTING

The significance of ducting to ensure an effective ventilation system cannot be understated. According to the BSRIA BG 46/2015 A Guide to Installation of Domestic Ventilation Systems "*poor quality installation of flexible ductwork is the principal cause of ventilation problems in domestic buildings*".

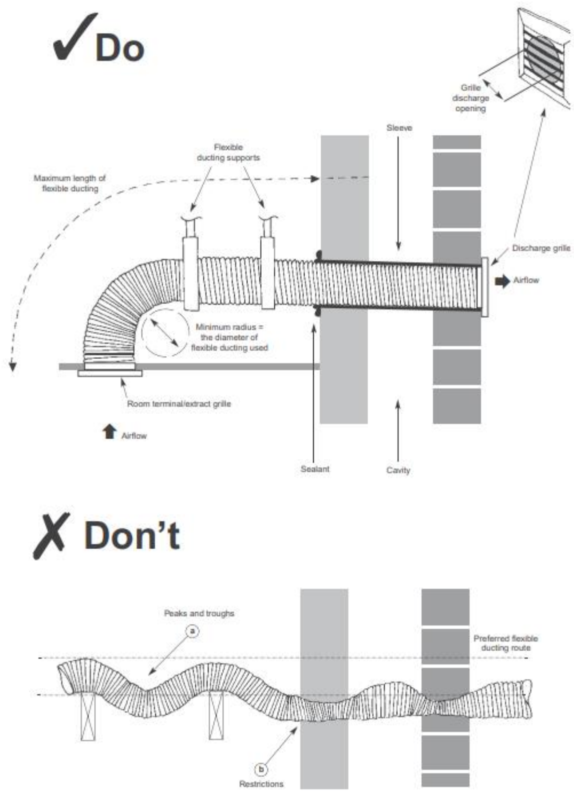

Fig 10. Taken from the Domestic Ventilation Compliance Guide to illustrate ducting good practice

An inspection of the ducting MUST always form part of the inspection. The surveyor should note the type, length and route of any ducting.

Flexible ducting will dramatically reduce the performance of the ventilation system. Round rigid ducting will provide the best performance. Flexible ducting only being used to make final connections and its length should always be kept to a minimum.

For System 1 axial fans the length of flexible ducting should be less than 1.5 meters, less than 6 meters for centrifugal fans with an extract rate of 6 to 30l/s, or less than 3 meters for centrifugal fans with an extract rate of 31 to 60 l/s.

Any connections in ducting should be done with an appropriate rigid connector and not with tape.

Where flexible ducting has been used it should be adequately supported to prevent any peaks or troughs and pulled taught to 90 percent of its maximum length. However, over extension may reduce the radius of the ducting. The radius of the ducting should remain constant and not be reduced to fit through masonry.

With any ducting there should be minimal bends, avoiding sharp bends where possible. For System 1, bends should be limited to two for up to 30l/s and to one for higher rates of extraction.

Ducting passing through unheated areas should be insulated otherwise condensation can occur within the ducting and any vertical ducting will require a condensation trap.

Ducting should be installed with a fall towards the discharge grille.

Note should be made of any shared ducting. In apartments this may form part of a larger ventilation system but even single domestic dwelling extractor fans may have been installed with shared ducting. This may potentially hinder the performance of the extractor fans and should be noted.

8. SPECIFICATION AND IMPLEMENTATION OF REPAIR STRATEGIES

Inappropriate moisture levels in buildings are considered to be the cause of the majority of all building failures. Understanding all sources of moisture is essential and this document has focused on just one type of moisture within the built environment. Determining what is out of balance within the internal environment is crucial to be able to devise and implement the appropriate remedial strategy. A methodology has been outlined in this document to understand the relationship between moisture production, ventilation and heating – ultimately leading to the reduction in remediation and repair costs.

However, it is beyond the scope of this document to provide guidance on specification ventilation strategies but what this document does highlight, is methods of diagnosis to accurately decide on any appropriate or necessary repair strategy which will be covered in future PCA documents.

9. OTHER SOURCES OF INFORMATION

This guidance note should be read in conjunction with;

British Standards

From: BSI Publications, Linford Wood, Milton Keynes MK14 6LE

- BS 5250:2011 – Code of Practice for Control of Condensation in Buildings
- BS 5925: 1991 - Code of practice for ventilation principles and designing for natural ventilation

Property Care Association (Downloadable from www.property-care.org)

- Certificated Surveyor in Remedial Treatment (CSRT) – Examination syllabus
- Certificated Surveyor in Structural Waterproofing (CSSW) – Examination syllabus
- Code of Practice for the Provision and Control of Ventilation in Buildings
- Code of Practice for the Identification and Control of Dampness in Buildings
- Best Practice Guidance Note - Positive Input Ventilation Systems

Building Regulations 2010

- Approved Document A Structure
- Approved Document B Fire Safety
- Approved Document F Ventilation. Applicable in England and Wales.
- Approved Document J Gas Spillage
- Approved Document L1B Conservation of Fuel & Power
- Approved Document P Electrical Safety
- Domestic Ventilation Compliance Guide

Other publications

- BSRIA Guide BG46/ 2015
- CIBSE Guide B. Heating, Ventilating, Air Conditioning and Refrigeration. Available from the Chartered Institution of Building Services Engineers, Delta House, 222 Balham High Road, London SW12 9BS.
- Energy Saving Trust. GPG 268 – Energy efficient ventilation in dwellings – a guide for specifiers. 2006.
- HM Government - Domestic Building Services Compliance Guide
- Technical Handbooks. Applicable in Scotland. Available online from Scottish Building Standards at http://www.sbsa.gov.uk
- Technical Booklet K Ventilation. Applicable in Northern Ireland. Available online at www.buildingregulationsni.gov.uk

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