Technical Note No. 74 – supersedes TN 32

VENTILATION

Adequate ventilation provision is vital in providing pleasant, comfortable internal conditions with suitable air quality in both domestic and non-domestic buildings. Ventilation may be provided by natural or mechanical means, or by a combination of the two (mixed mode/hybrid ventilation). It is important that ventilation requirements are met whilst minimising the energy use of the building.

This Technical Note discusses ventilation requirements in the UK, and how they may be achieved, concentrating on ventilation through the façade.

Introduction

It has been estimated that up to eighty per cent of our time is spent indoors. With the introduction of more airtight building construction, and modern lifestyles generating increased amounts of moisture and air pollution within both domestic and commercial buildings, ventilation has become more of a concern. Heating, smoking, cooking and breathing are all sources of atmospheric pollutants and water vapour. It has been shown that adequate ventilation is essential for the well being and health of building occupants and to the fabric of the building itself. Correct ventilation of domestic and commercial buildings is therefore essential.

Ventilation is simply the removal of stale indoor air from a building and its replacement with fresh outside air.

Ventilation is required for one or more of the following purposes;

- Provision of fresh air for breathing,
- Dilution and removal of airborne pollutants, including odours,
- Control of excess humidity,
- Provision of air for fuel-burning appliances (covered under Building Regulations Approved Document J (ADJ)).

Ventilation may also provide a means to control thermal comfort.

In domestic properties the building façade, especially the window element, provides the designer with the means of supplying ventilation to the building and its occupants.

Commercial buildings generally benefit from an integrated approach that commonly incorporates some form of air handling plant together with air conditioning; however the use of natural ventilation in commercial buildings is becoming increasingly popular in order to reduce their energy use/carbon emissions.

Different buildings require different levels of ventilation. Guidance on ensuring sufficient ventilation is given in Building Regulations Approved Document F (ADF), Means of ventilation, 2010. The Building Regulations are discussed further in Appendix A

Equivalent guidance in Scotland is given in Technical Handbook 3, 2010 for guidance on ventilation requirements and Technical Handbook 6, 2010 for guidance on mechanical ventilation and air conditioning. Readers in Northern Ireland should refer to Technical Booklet K, 1998.

Types of ventilation

The ventilation types identified in the Approved Documents are:

- Purge ventilation,
- Background ventilation,
- Extract ventilation,
- Permanent ventilation.

Definitions

Purge ventilation
Manually controlled ventilation of rooms or spaces at a relatively high rate to rapidly dilute pollutants and or water vapour.

Purge ventilation may be provided by natural means (for example by openable windows) or by mechanical means.

Purge ventilation is typically an order of magnitude greater than background ventilation. In addition to removing high levels of contaminants, purge ventilation can also help to remove excess heat from the space, assisting thermal comfort in summer.

Background ventilation
Nominally continuous ventilation of rooms or spaces at a relatively low rate to dilute and remove pollutants and water vapour, as well as supplying outdoor air into the building.

Extract ventilation
The removal of air directly from a space or spaces to outside.

Extract ventilation may be by natural means (for example by passive stack ventilation) or by mechanical means (for example by an extract fan or central system).

Permanent ventilation
Permanent ventilation is that which is required to supply combustion air to all rooms containing a non-room sealed fuel-burning appliance. This is covered by Building Regulations ADJ, 2010.

Control of ventilation

It is important that ventilation is controllable to maintain reasonable indoor air quality and avoid waste of energy. Windows can be operated manually or controlled automatically.

Where trickle ventilators are under manual control it is vital that they are positioned and used correctly. If trickle ventilators are draughty or noisy there is the danger that occupants will simply close them and never open them again, which can lead to a reduction of internal air quality as well as issues such as condensation, particularly in domestic situations. For this reason it is recommended that trickle ventilators are positioned typically 1.7m above floor level to avoid discomfort due to draughts.

In many non-domestic buildings (and indeed in some dwellings) sophisticated HVAC systems are used in order to control the internal environmental conditions. Such systems employ sensors to detect the level of occupancy, temperature, water vapour or other pollutants and adjust the ventilation rate accordingly in order to avoid over ventilation and so reduce energy consumption.

Automated facades
Automating the façade has many potential benefits in terms of ventilating a building.

When using external air cooling an automated façade may be operated in advance of the internal space overheating. Opening the windows in this way allows smaller opening distances to be used which has benefits in terms of draughts and acoustics. It also takes the decision making away from the occupants and has been demonstrated to be very effective.

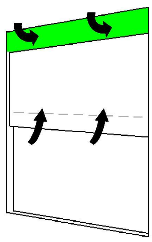
More advanced systems allow windows to be opened very small distances, and can therefore be used to provide controlled background ventilation.

There are also obvious benefits in automating windows that are inaccessible, such as those in the roof of an atrium.

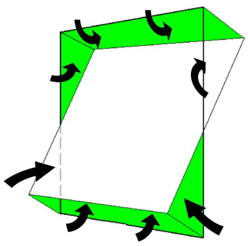
For further details refer to the CWCT publication 'Automated façade control'.

Airflow through windows

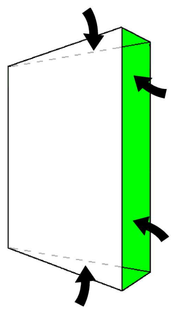
The true effectiveness of the ventilation supplied by a window is directly linked to its style and proportions; deeper (taller) windows ventilate more effectively but can cause a nuisance due to draughts. Different types of window produce varying airflows into and out of the building.



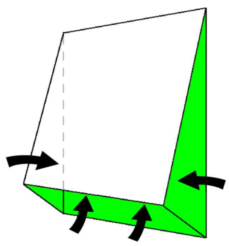
Vertical slider



Horizontal pivot



Side hung



Top hung

Figure 1 –Ventilation through opening windows

It should also be noted that details such as window cills and reveals may significantly reduce the ventilation capacity of a window. Where such details are present it is important that the correct dimensions are used when calculating the opening area, as shown in Figure 2 below.

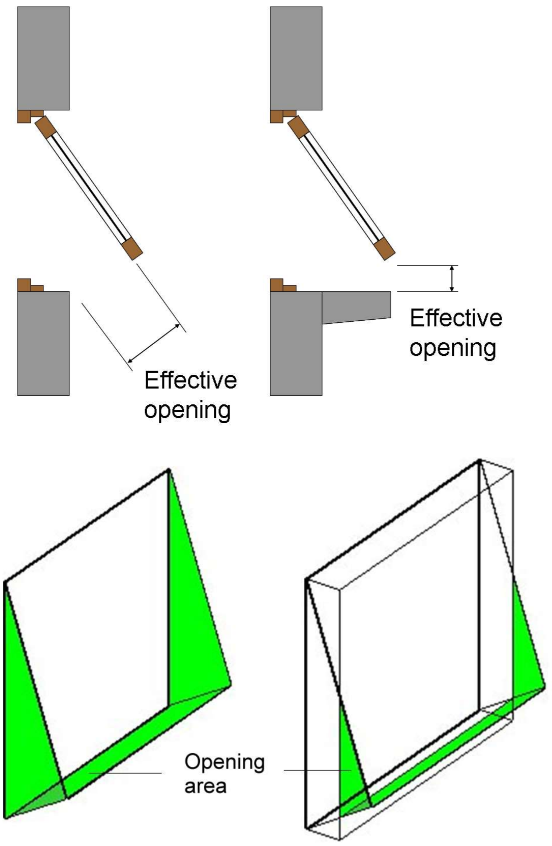


Figure 2 – Effect of window cills and reveals

CIBSE AM10 recognises that the above details may significantly alter the airflow through the window. Where natural ventilation is to be used for cooling it is crucial that realistic values are used for the effective opening area of the window.

In addition to window details, the position of windows relative to each other is also significant. When windows are close together they may effectively shield each other and therefore including the side areas in the free area calculation is sometimes not appropriate.

These issues should be discussed with building control to ensure that sufficient free opening area is provided.

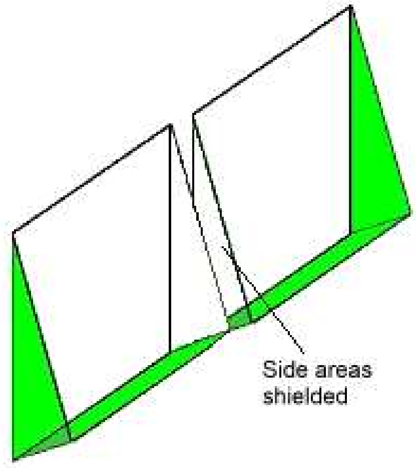


Figure 3 – Window positioning and free opening area

Louvres

Louvres may be used to supply ventilation air to a building. This may be supply air for a mechanical system, or air for natural ventilation.

Louvres may be fixed (in which case some means of controlling the incoming air must be provided elsewhere) or adjustable. If they are adjustable they should seal tightly when they are closed to minimise unwanted infiltration.

Consideration must also be given to the weathertightness of louvres. They must either not allow water past or be detailed such that any water that gets past the external louvre is effectively drained back to the outside or can evaporate without causing any damage.

BS EN 13030 specifies a method for measuring the water rejection performance of louvres subject to simulated rain and wind pressures, both with and without air flow through the louvre under test.

The standard also gives a method to establish the air pressure loss through the louvre (the actual flow rate divided by the theoretical air flow rate) at various air flow rates.

Figure 4 – Ventilation louvre (Passivent©)

Methods of providing ventilation

Purge ventilation of dwellings

Purge ventilation may be required to remove odours from cooking, or steam from bathing etc. Adequate purge ventilation may be achieved by the use of openable windows and/or external doors.

The aim of the guidance below is to achieve a purge ventilation rate of 4 air changes per hour (ach).

The guidance given below is a simplification of the guidance given in BS 5925:1991, Code of practice for ventilation principles and designing for natural ventilation. These values are based on single sided ventilation for dwellings in an urban environment. Depending on the design of the building and the external climate, it may be possible to achieve this ventilation rate through a smaller opening area.

Windows
For a hinged or pivot window that opens 30° or more or for parallel sliding windows (eg vertical sliding sash windows), the height multiplied by the width of the opening part should be at least 5 per cent of the floor area.

For a hinged or pivot window that opens between 15° and 30°, the height multiplied by the width of the opening part should be at least 10 per cent of the floor area.

This window area calculation here is different to the effective opening area discussed earlier (Figures 2 and 3). This calculation is based simply on the size of the window opening in plane and excludes the effects of reveals and cills etc, and should only be used for calculating appropriate areas for purge ventilation rather than cooling ventilation.

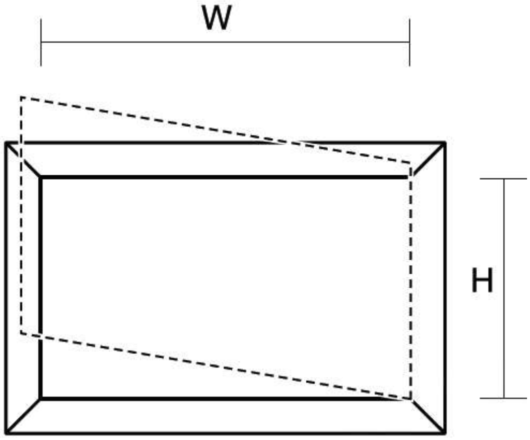


Figure 5 – Window opening area for purge ventilation (from ADF 2010)

Using this simplified approach, if the window opens less than 15° it is not suitable for providing purge ventilation and other provisions should be made.

If the room contains more than one openable window, the areas of all the opening parts may be added together to achieve the required proportion of floor area. The required proportion of floor area is determined by the opening angle of the largest window in the room. Therefore if the opening angle of the largest window in the room was 15°, the total required window area (of all suitable windows) will be 10 per cent of the floor area.

Where there is the potential for people to fall from height through open windows the window opening should be restricted. Use of window restrictors to limit the opening (normally to 100mm) will limit the ventilation opening. An alternative is to use bars or rails to prevent falls, or to have high level openings for ventilation.

It may be appropriate to allow occupants to disengage window restrictors when purge ventilation is required. Purge ventilation is usually only required for short periods of time and therefore this may be acceptable. If restrictors are disengaged they should be designed so that they automatically reengage when the window is closed.

Doors
For an external door, the height multiplied by the width of the opening part should be at least 5 per cent of the floor area.

If the room contains more than one external door, the area of all the opening parts may be added to achieve at least 5 per cent of the floor area of the room.

If the room contains a combination of at least one external door and at least one openable window, the areas of all the opening parts may be added to achieve at least 5 per cent of the floor area of the room.

Purge ventilation of non-domestic buildings

Purge ventilation provision is required in every office space. The total ventilation should be sufficient to reduce pollutants to an acceptable level before the space is occupied.

The purged air should be taken directly to outside and should not be re-circulated to any other part of the building.

There are normally more options for the removal of high concentrations of pollutants from office spaces than for dwellings. This may include simply leaving rooms unoccupied until acceptable levels are achieved. Hence, general guidance is provided in the Regulations rather than specifying any ventilation rates.

Background ventilation

Background ventilation can be provided by means of:

- Trickle ventilators within windows
- Airbricks with hit-and-miss grilles
- Windows with suitably designed hardware

Trickle ventilators

It is important that background ventilation is controllable so that it can maintain reasonable indoor air quality and avoid waste of energy. Controls can be either manual (ie, operated by the user) or automatic in response to certain conditions.

Most trickle vent manufacturers produce ventilators that can be operated by remote means, i.e. cords or rigid rods. These are especially useful in locations where physically reaching the vent is difficult, such as over sinks, or for use when people are elderly or have medical conditions that prevent them using the conventional operating methods.

There are three principal methods of providing ventilators within windows:

- Through the frame or sash
- Through a purpose-designed extension to the window head
- Through a vent glazed into the frame above the glass

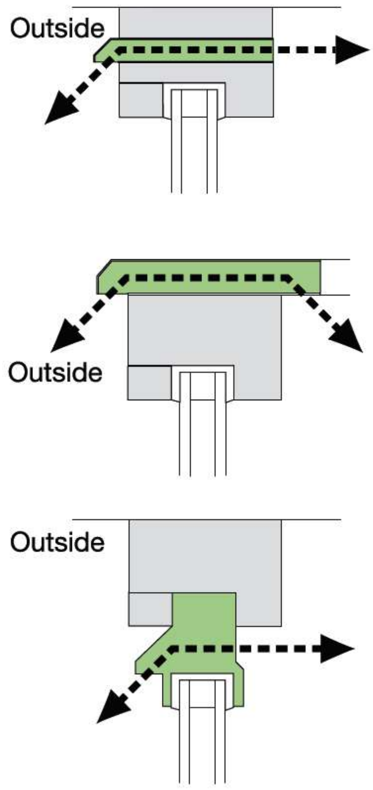


Figure 6 – Trickle ventilator positions (from ADF 2010)

Through the frame or sash
Through the frame ventilators are manufactured in both aluminium and plastic and usually comprise two major parts, an external grille or hood and an internal section that houses the controllable element of the vent, usually a sleeve section is also available. Most internal sections are designed to deflect the airflow upwards to avoid discomfort to the building occupants and to discourage them from blocking the vents.

This type of ventilator is applied over a routed slot within the window framing element and clips or screws into place; many are now fitted with seals to help reduce air infiltration when they are closed.

In all cases the system must contain an integral insect screen.

When used in PVC-U windows, trickle ventilators that pass through the frame or sash member may need to be sleeved if the frame is reinforced in order to prevent condensation forming on the steel/aluminium reinforcement and causing corrosion problems. If however the reinforcement is cut back to accommodate the ventilator the strength of the framing member may be compromised and the window performance impaired.

With timber windows, the frames should be pressure treated after all the machining has been carried out. If the vents are being fitted into pre-treated timber frames then adequate preservative must be applied to the machined area in order to prevent decay.

Some aluminium systems companies recommend that cut aluminium faces should be treated with a compatible surface treatment or air drying paint. Such consideration must be given to sites in coastal locations or those subject to other aggressive environments.

Through purpose designed head section or head extension profile
The ventilators used in this method are the same as those used in through frame. However this method of applying a trickle ventilator is generally more favoured by the manufacturer especially when using PVC-U frames as it does not require the fabricator to carry out any additional operations within the window manufacturing process and a separate production line is usually set up producing head vent sections. The completed head vent sections are then fixed to the finished window.

A further benefit of this method is that the head sections are generally purpose designed and afford the ventilation opening a degree of protection against severe weather and can offer an aesthetically pleasing detail.

Purpose made sections usually make provision for internal building finishes allowing for dry lining etc. without impairing the ventilation function.

Glazed-in ventilators
Sometimes called over glass ventilators these ventilators sit on top of the sealed unit and are glazed into the frame along with the sealed unit. They are available for a range of standard double glazed sealed unit thicknesses and for single glazing. Glazed-in ventilators are constructed in both aluminium and PVC-U. Those which are constructed of aluminium should incorporate a thermal break. Recent developments have seen the introduction of vents that close positively with wind pressure and improve the weather performance.

Care should be taken with glazed-in ventilators to ensure compatibility with opening lights, particularly sliding sashes, as the ventilator may prevent proper opening of the window.

This type of ventilator may be more noticeable by virtue that it physically increases the sight lines, and can lead to unaligned edges, but sensible positioning can alleviate this problem.

Air flow through trickle/background ventilators
The equivalent area is used in Building Regulations ADF instead of the free area for the sizing of background ventilators (including trickle ventilators) because it is a better measure of the air flow performance.

The standard method of measuring the equivalent area for an air transfer device, derived from its air-flow performance at 1 Pa pressure difference, is given in BS EN 13141-1**.**

As an equivalent area cannot be verified with a ruler, it will be difficult to demonstrate to building control that trickle ventilators have the correct equivalent area. It is therefore preferable to use ventilators that have the equivalent area marked on the product.

Self-limiting trickle ventilators
In order to reduce the possibility of discomfort due to draughts, self limiting trickle ventilators may be used. These have an aerofoil flap within the air inlet which lifts at high flow rates (ie when it is windy) and constricts the opening. When the wind speed drops the aerofoil falls back down due to gravity and allows normal operation.

Trickle ventilators that monitor the humidity within the air are also available. They open and close according to the relative humidity within each room. Requiring no electrical supply, this type of ventilator is perceived to be more energy efficient and is particularly useful in kitchen and bathroom applications where humidity can fluctuate widely.

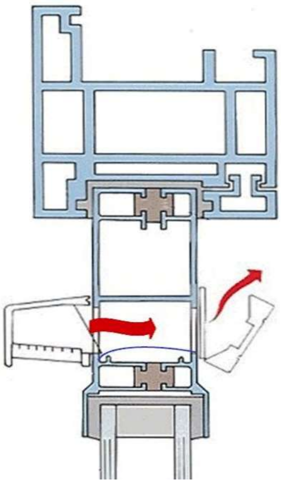


Figure 7 – Self limiting trickle ventilator in 'open' position

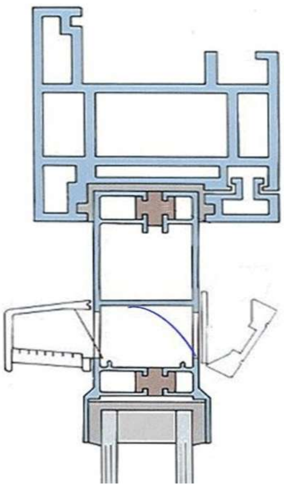


Figure 8 – Self limiting trickle ventilator in 'closed' position

The use of trickle ventilators, particularly those glazed into the frame will reduce the glazed area of the window, and therefore the amount of daylight that will be admitted.

The Building Regulations do not specify minimum daylight requirements. They point the reader to BS 8206-2, Code of practice for daylighting, which gives guidance on maintaining adequate levels of daylight.

Reducing the area of glazing may increase the overall U-value of a window.

It should also be noted that through the frame/sash trickle ventilators are often excluded from U-value calculations/simulations of window frames. Therefore actual U-values and surface temperatures may be lower than those calculated, resulting in a higher heat flow rate and an increased risk of internal surface condensation.

Acoustic performance

Trickle ventilators may need to be provided in locations that are subject to high levels of noise pollution e.g. adjacent to busy roads or railway tracks. Ventilators can be supplied which attenuate the noise however these tend to be larger than standard ventilators due to the requirement for a sound-absorbing acoustic material. This type of ventilator is able to provide up to 48dB sound reduction, but may provide less. It should also be noted that the longer and less streamlined flow paths may reduce the air flow rate. Therefore products should state their equivalent area in addition to their acoustic performance.

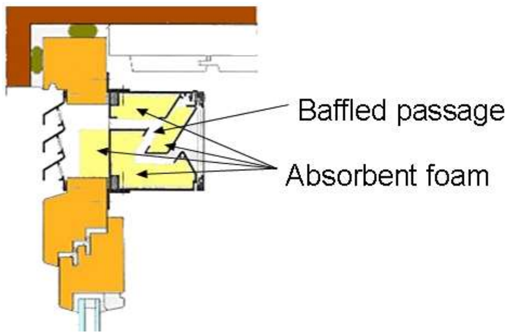


Figure 9 – Acoustic trickle ventilator

Other means of providing background ventilation

Air bricks with hit and miss grilles

Usually provided within the façade of the building this method uses proprietary airbricks on the outside of the building, and a controllable hit and miss grille on the inside of the building. This form of providing ventilation is however usually more expensive owing to the construction costs of flashings and cavity trays, etc.

Purpose-designed window hardware

It is also possible to provide background ventilation using window hardware that has been designed to offer two opening positions. This is usually achieved on casement windows by fitting strikers which have two positions for the espagnolettes or shoot bolts, sometimes called night vents. Windows fitted with cockspur handles may also have purpose-designed handles but these are becoming obsolete due to the aesthetic considerations of using such large handles.

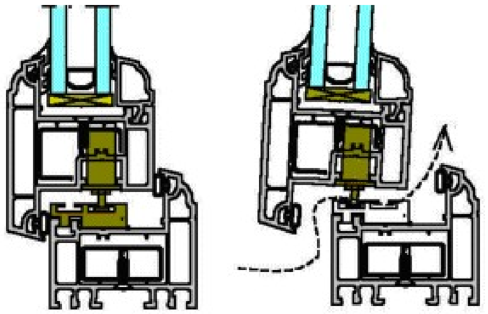


Figure 10 – Night vent

Providing background ventilation by this method is usually confined to windows above ground floor because of the risk to security. Locking handles may be used but this can conflict with the need to provide escape in the event of a fire, see Building Regulations ADB1 *means of warning and escape.*

It should be noted that ADF 2010 does not recommend this method of providing background ventilation because of the difficulty of measuring the equivalent area, the greater likelihood of draughts and the potential increased security risk in some locations.

Extract ventilation

Extract ventilation may be provided by natural means (for example passive stack ventilation) or by mechanical means (for example an extract fan or central system).

Passive stack ventilation is a ventilation system using ducts from terminals in the ceiling of rooms to terminals on the roof that extract air to outside by a combination of the natural thermal stack effect and the pressure effects of wind passing over the roof of the building.

Extract ventilation is required where most water vapour and/or pollutants are released, for example due to cooking, bathing or photocopying. This is to minimise their spread to the rest of the building. This extract may be either continuous or intermittent.

The precise requirements for extract ventilation will depend on the type of building (dwelling or non dwelling) and the general ventilation strategy (for example natural or mechanically ventilated). Section 5 and Section 6 of Building Regulations ADF give guidance on dwellings and non dwellings respectively.

Double facades

Double facades may be used as a means of increasing the ventilation in a building. There are many different configurations depending on the type of building and the ventilation strategy employed.

In simple terms the thermal stack effect created by the cavity of the double skin façade will draw air out of the building. This in turn will be replaced by fresh air, which may be used for background or cooling ventilation.

The use of a double skin façade may allow for opening windows to be used without restrictors, as the opening will be into the cavity rather than directly to the outside. This would allow for a greater effective opening area, and therefore greater air flow through the window.

Opening windows in tall buildings are not usually acceptable due to the high wind speeds involved, in addition to the obvious safety concerns. Again, having windows that open into the cavity of a double skin façade may overcome these issues and may allow a more flexible ventilation strategy for the building.

In colder climates the cavity may also be used to pre-heat the incoming air so that less heating is required to provide a comfortable internal environment.

Testing

Trickle ventilators

As previously discussed the air flow rate through a trickle ventilator is measured according to BS EN 13141-1. This result is also the basis for calculating the equivalent area of the trickle ventilation.

BS EN 13141-1 has a test procedure to assess the air tightness of a trickle ventilator (‘closable externally mounted air transfer device’) when closed. The method is the same as that used to assess the air flow rate but with the device closed.

BS EN 13141-1 also has a test procedure for water tightness. The method involves applying a quantity of water and an air pressure under defined conditions, to the outside surface of the externally mounted air transfer device and to record any water penetration. The principle is based on the method given in EN 1027.

Windows

It should be borne in mind when specifying ventilators that BS 6375: Part 1 2009 – 'Performance of windows and doors: Classification of weathertightness and guidance on selection and specification' states that there is no requirement to record the flow of air through a controlled ventilator when closed. For window classification purposes, permanent and controlled ventilation devices, if any, shall be taped over except when it is required to determine the amount of air flow through such devices.

To establish air leakage through the window and controllable vent (in the closed position), the air permeability test can be repeated with the vent closed but not taped. This information should be included in the test report.

It is therefore incumbent upon the designer to ensure that the specified product performs satisfactorily.

The same procedure as above can also be applied to the test for watertightness.

Whole building air leakage

Whole building air leakage testing is covered by Building Regulations ADL with the approved procedure given in the ATTMA publication 'Measuring air permeability of building envelopes'.

The façade requirements include;

- All external doors and windows should be closed (but not artificially sealed).
- Background trickle ventilators, passive ventilation systems and permanently open uncontrolled natural ventilation openings should be temporarily sealed.

This is a change from the 2006 requirements which stated that trickle ventilators and like should be closed but not artificially sealed.

The Regulations in Scotland (Technical Handbook 6) and Northern Ireland (Technical Booklet F) both reference the ATTMA guidance document.

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CWCT
The Studio, Entry Hill, Bath, BA2 5LY

T: +44 (0) 1225 330945
cwct@cwct.co.uk

APPENDIX A

Building Regulations

Ventilation requirements in buildings are covered in the Building Regulations AD F, Means of ventilation, 2010.

Legal requirements
There are new legal requirements in ADF 2010, in order to ensure that installed systems are capable of providing sufficient ventilation rates, and operated effectively. The new requirements are;

- All fixed mechanical systems, where they can be tested and adjusted, shall be commissioned and commissioning notice given to building control,
- For mechanical ventilation systems installed in new dwellings, air flow rates shall be measured on site and a notice given to building control. This applies to intermittently used extract fans and cooker hoods, as well as continuously running systems,
- The owner shall be given sufficient information about the ventilation system and its maintenance requirements so that the ventilation system can be operated to provide adequate air flow.

Changes to Building Regulations ADF
Since the introduction of ADL 2006 the level of inadvertent infiltration has significantly reduced. Therefore the provision for adequate, controlled ventilation is increasingly important in order to maintain good internal air quality and guard against condensation, mould growth etc.

ADF 2006 was designed to work at a minimum air permeability of 3 $m^3/h/m^2$ at a pressure difference of 50 Pa, and initial results from a study of ADL compliant dwellings show that infiltration rates for some are getting closer to the low levels that may give rise to health concerns.

ADF 2010 has been revised to ensure ventilation standards are not undermined by prospective changes in energy efficiency requirements that encourage increased airtightness.

One of the key tasks in the revision was how dwellings should be ventilated in the future. It is likely to become more challenging to provide adequate ventilation rates using natural ventilation and this will give impetus to mechanical ventilation systems, common in low energy houses in other countries.

The focus of the changes to ADF is on new dwellings. Additional requirements and guidance is provided for;

- Ventilation of more airtight dwellings,
- Making domestic ventilation systems a controlled service,
- Installation and commissioning of ventilation systems,
- Noise levels from continuous mechanical systems.

New dwellings
ADF gives the main ways of complying with the ventilation requirements of the Building Regulations as,

- Providing certain ventilation rates,
- Following the guidance on ventilation systems given.

There are different requirements depending on the type of ventilation system used, and whether or not the dwelling has a basement. Alternatively the regulations can be met using other ventilation systems provided it can be demonstrated to the Building Control Body that they satisfy the requirement.

Ventilation rates
Extract ventilation to the outside is required in each kitchen, utility room and bathroom, and for sanitary accommodation. The extract can be continuous or intermittent, providing the minimum values given in Table 5a of ADF are met.

The whole dwelling ventilation rate for the supply air to the habitable rooms in a dwelling should be no less than those specified in Table 5b in ADF. The whole dwelling ventilation rate required depends on the number of bedrooms in the dwelling.

In addition there is a requirement that purge ventilation should be capable of extracting a minimum of four air changes per hour directly to the outside in each habitable room. Windows and doors will normally provide this function.

All natural and mechanical systems should be fully commissioned, with guidance given in the Domestic ventilation compliance guide.

Ventilation systems for dwellings
There are different requirements for the extract and whole dwelling ventilation depending on the;

- Type of system used,
- Floor area and number of bedrooms in the dwelling
- Design air permeability.

The systems covered are;

- Background ventilators and intermittent extract fans,
- Passive stack ventilation,
- Continuous mechanical extract,
- Continuous mechanical supply and extract with heat recovery.

In addition, guidance is provided on performance test methods for the products chosen.

If the dwelling has a basement that is connected to the rest of the dwelling by a large permanent opening (for example a large open stairway), the whole dwelling should be treated as a multi-storey dwelling and ventilated accordingly. Where the basement is not connected to the rest of the dwelling by a large permanent opening, it should be treated separately.

New buildings other than dwellings
ADF sets out guidance for the following range of building types;

- Offices
- Car parks
- Other building types

This Technical note only considers the ventilation of offices.

It should be noted that the ventilation provisions given in the Building Regulations will not necessarily meet cooling needs.

Ventilation rates
Extract ventilation to the outside is required in rooms containing printers and photocopiers in high use, sanitary accommodation and food preparation areas.

In addition, there is a requirement for a whole building ventilation rate for air supply to offices. The value given (10 l/s per person) is where there are no significant pollutant sources. Where there are significant levels of pollutants, adequate air supply can be achieved by following the calculation provided in CIBSE Guide A.

Natural ventilation of rooms
Extract ventilation requirements are the same as those for other office buildings. For whole building and purge ventilation requirements the guidance in CIBSE Application Manual AM 10: Natural ventilation in non-domestic buildings, should be followed.

Noise
The noise associated with ventilation systems is not controlled under the Building Regulations.

Such noise however may be disturbing to the occupants of a building and it is recommended that measures be taken to minimise noise disturbance. For example, in a noisy area it may be appropriate to use sound attenuating ventilation products to reduce noise entering the building.

Measures to minimise externally emitted noise from ventilation systems should also be considered in areas where such noise may disturb people who are outside the building.

Noise generated by ventilation fans and noise from the fan unit may disturb the occupants of the building and so discourage their use. Therefor the designer should consider minimising noise by careful design and the specification of quieter products.

APPENDIX B

Building Bulletin 101

This Building Bulletin provides a framework in support of the Building Regulations for the adequate provision of ventilation in schools. It deals with the design of school buildings to meet the ventilation requirements of both The School Premises Regulations and the Building Regulations Part F (Ventilation).

Natural ventilation for teaching and learning spaces
Purpose-provided ventilation (i.e. controllable devices to supply air to and extract air from a building) should provide external air supply to all teaching and learning spaces of:

- a minimum of 3 l/s per person (litres per second per person), and
- a minimum daily average of 5 l/s per person, and
- the capability of achieving a minimum of 8 l/s per person at any occupied time. Additional ventilators could be used to provide this extra ventilation e.g. supplementing windows with the addition of louvres or stacks. This ventilation may not be required at all times of occupancy, but it should be achievable under the control of the occupant. When fresh air is supplied at a rate of 8 l/s per person, the carbon dioxide concentration will generally remain below 1000 ppm.

These flow rates should be based on the maximum number of occupants likely to occupy the space.

The Department for Education and Skills has provided the ClassVent calculator to be used with Building Bulletin 101 that enables a designer to rapidly calculate areas for airflows into and out of a classroom.

Mechanical ventilation for teaching and learning spaces
If a mechanical ventilation system is specified, it should be commissioned to provide a minimum daily average of 5 l/s per person. In addition, it should have the capability of achieving a minimum of 8 l/s per person at any occupied time.

Overheating
Three parameters have been developed which indicate when overheating is likely to be problematic. These standards apply outside the heating season and are for the occupied period of 09:00 to 15:30, Monday to Friday, from 1st May to 30th September.

- the number of hours for which a threshold temperature is exceeded
- the degree to which the internal temperature exceeds the external temperature
- the maximum temperature experienced at any occupied time.

In order to assist in determining possible overheating in classrooms as indicated by these performance parameters, the ClassCool tool has been published by the DfES. The ClassCool results are presented in terms of the above performance parameters and would demonstrate compliance with the performance standards.