

# Ventilation

# F

## Building Regulations 2009

## Technical Guidance Document



Comhshaol, Oidhreacht agus Rialtas Áitiúil  
Environment, Heritage and Local Government



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# *Building Regulations 2009*

## *Technical Guidance Document F*

### *Ventilation*

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#### **Introduction**

This document has been published by the Minister for the Environment, Heritage and Local Government under article 7 of the Building Regulations 1997. It provides guidance in relation to application of Part F of the Second Schedule to the Regulations as inserted by the Building Regulations (Amendment) Regulations 2009 (S.I. No. 556 of 2009). The document should be read in conjunction with the Building Regulations 1997 and other documents published under these Regulations.

In general, Building Regulations apply to the construction of new buildings and to extensions and material alterations to buildings. In addition, certain parts of the Regulations apply to existing buildings where a material change of use takes place. Otherwise, Building Regulations do not apply to buildings constructed prior to 1 June, 1992.

#### **Transitional Arrangements**

In general, this document applies to works, or buildings in which a material change of use takes place, where the works or the change of use commence or takes place, as the case may be, on or after 1 October 2010. Technical Guidance Document F - Ventilation dated 2002, also ceases to have effect from that date. However, the latter document may continue to be used in the case of buildings

- where the works or the change of use commences or takes place, as the case may be, on or before 30 September 2010, or
- where planning approval or permission has been applied for on or before 30 September 2010, and substantial work has been completed by 30 September 2011,
- or a notice pursuant to Part 8 of the Planning and Development Regulations 2001, has been published on or before 30 September 2010, and substantial work has been completed by 30 September 2011.

“Substantial work has been completed” means that the structure of the external walls has been erected.

#### **The Guidance**

The materials, methods of construction, standards and other specifications (including technical specifications) which are referred to in this document are those which are likely to be suitable for the purposes of the Regulations. Where works are carried out in accordance with the guidance in this document, this will, prima facie, indicate compliance with Part F of the Second Schedule to the Building Regulations. However, the adoption of an approach other than that outlined in the guidance is not precluded provided that the relevant requirements of the Regulations are complied with. Those involved in the design and construction of a building may be required by the relevant building control authority to provide such evidence as is necessary to establish that the requirements of the Building Regulations are being complied with.

#### **Existing Buildings**

In the case of material alterations or change of use of existing buildings, the adoption without modification of the guidance in this document may not, in all circumstances, be appropriate. In particular, the adherence to guidance, including codes, standards or technical specifications, intended for application to new work may be unduly restrictive or impracticable. Buildings of architectural or historical interest are especially likely to give rise to such circumstances. In these situations, alternative approaches based on the principles contained in the document may be more relevant and should be considered.

#### **Technical Specifications**

Building Regulations are made for specific purposes, e.g. to provide, in relation to buildings, for the health, safety and welfare of persons, the conservation of energy and access for disabled persons. Technical specifications (including harmonised European Standards, European Technical Approvals, National Standards and Agrément Certificates) are relevant to the extent that they relate to these considerations. Any reference to a technical specification is a reference to so much of the specification as is relevant in the context in which it arises. A reference to a technical specification is to the latest edition (including any amendments,

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supplements or addenda) current at the date of publication of this Technical Guidance Document. Technical specifications may also address other aspects not covered by the Regulations. However, if this version of the technical specification is subsequently revised or updated by the issuing body, the new version may be used as a source of guidance provided that it continues to address the relevant requirements of the Regulations.

A list of “other useful standards and publications” that deal with matters relating to this part of the Building Regulations is included at the end of this document. These standards and publications may be used as a source of further information but do not form part of the guidance.

### **Materials and Workmanship**

Under Part D of the Second Schedule to the Building Regulations, building work to which the Regulations apply must be carried out with proper materials and in a workmanlike manner. Guidance in relation to compliance with Part D is contained in Technical Guidance Document D.

### **Interpretation**

In this document, a reference to a section, subsection, part, paragraph or diagram is, unless otherwise stated, a reference to a section, subsection, part, paragraph or diagram, as the case may be, of this document. A reference to another Technical Guidance Document is a reference to the latest edition of a document published by the Minister for the Environment, Heritage and Local Government under article 7 of the Building Regulations, 1997.

Diagrams are used in this document to illustrate particular aspects of construction - they may not show all the details of construction.

# Ventilation

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## Building Regulations - The Requirement

Part F of the Second Schedule to the Building Regulations 1997 is amended to read as follows:

Means of ventilation.	F 1	Adequate means of ventilation shall be provided for people in buildings. This shall be achieved by a) limiting the moisture content of the air within the building so that it does not contribute to condensation and mould growth, and b) limiting the concentration of harmful pollutants in the air within the building.
Condensation in roofs.	F2	Adequate provision shall be made to prevent excessive condensation in a roof or in a roof void above an insulated ceiling.

This Technical Guidance Document is divided into two sections.

Section 1 relates to the requirement in F1.

Section 2 relates to the requirement in F2.

# Section 1

## Means of Ventilation

Means of ventilation.	F 1	Adequate means of ventilation shall be provided for people in buildings. This shall be achieved by a) limiting the moisture content of the air within the building so that it does not contribute to condensation and mould growth, and b) limiting the concentration of harmful pollutants in the air within the building.
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### 1.1 General

**1.1.1** The Guidance in this document relates to non-complex buildings of normal design and construction. Section 1.2 deals with ventilation methods for dwellings including natural ventilation and mechanical ventilation with heat recovery. Section 1.3 deals with ventilation methods for buildings other than dwellings, in particular, offices and car parks.

**1.1.2** Ventilation is the supply of fresh outside air and the removal of stale indoor air to or from spaces in a building. It normally comprises a combination of purpose-provided ventilation and air infiltration. The purpose-provided ventilation may be provided by natural or mechanical means.

Air Infiltration is the uncontrollable air exchange between the inside and outside of a building through a wide range of air leakage paths in the building structure.

Purpose-provided ventilation is the controllable air exchange between the inside and outside of a building by means of a range of natural and/or mechanical devices.

**1.1.3** The means of ventilation should be capable of providing a satisfactory indoor air quality for human respiration in occupied areas of a building by

- rapidly diluting pollutants, including odours, and water vapour to levels which do not pose direct or indirect health risk;
- removing excess water vapour from areas where it is produced in significant quantities, such as kitchens, utility rooms, bathrooms and shower rooms so as to reduce the likelihood of creating conditions

that support the growth of mould, harmful bacteria, pathogens and allergens;

- removing harmful pollutants from areas where they are produced in significant quantities;
- providing an adequate supply of fresh air for persons using an area in a building;
- dispersing residual pollutants and water vapour.

**1.1.4** The means of ventilation used can have a significant effect on building energy use and thus can affect compliance with the requirements of Part L of the Building Regulations. It can also affect occupant comfort, e.g. through undesirable draughts or excessive air movement. The aim should be to provide adequate ventilation while limiting energy use and avoiding occupant discomfort.

**1.1.5** It is important to minimise the uncontrollable infiltration and supply sufficient purpose-provided ventilation. Air tightness measures to limit infiltration are covered in Part L of the Building Regulations. In general Technical Guidance Document F provides guidance on purpose-provided ventilation for buildings with an air permeability of  $5\text{m}^3/(\text{h}\cdot\text{m}^2)$  at 50pa or greater. It is important as buildings become more airtight that adequate ventilation is maintained. For this reason some guidance is also given for buildings with lower air permeability.

**1.1.6** Airborne pollutants include those that are released from materials and products used in construction, decoration and furnishing of a building, and those created as a result of the activities of the building occupants. Common pollutants in a dwelling are combustion products from unflued appliances (e.g. gas cookers) and chemical emissions from construction and consumer products. In an

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office building, body odour is the key pollutant but there are a number of other pollutant sources including building materials, furnishings, printers and photocopiers. Where pollutants can be reduced at source through the use of low emission materials and products this will improve indoor air quality.

The main sources of water vapour within buildings are kitchens, bathrooms, shower rooms, swimming pools and similar recreational areas, and areas used for clothes washing and similar processes utilising considerable amounts of water. Unflued combustion appliances (e.g. gas cookers) can also be significant sources.

**1.1.7** The reduction of house dust mite growth may be controlled in dwellings as part of an integrated approach that includes the removal of existing mite allergens, ventilation and heating and moisture control. Further information may be found in the World Health Organisation (WHO) publication *House dust mites*, Crowther D and Wilkinson T (2008).

**1.1.8** Ventilation to achieve the objectives set out in Paragraph 1.1.3 may be achieved by natural ventilation, or through the supply or extraction of air by mechanical means, or by a combination of these methods. The guidance in this document is based on the following general strategy:

*General ventilation* to provide fresh air to the building and remove water vapour and other pollutants that are released throughout the building (e.g. by building materials, furnishings, the presence and activities of occupants) and to dilute and disperse residual water vapour and pollutants. General ventilation provides nominal continuous air exchange. The ventilation rate may be reduced when the building is not occupied.

*Extract ventilation* from rooms or spaces where most water vapour and/or pollutants are released, e.g. where activities such as cooking, bathing or photocopying take place. The purpose of extract ventilation is to minimize the spread of water vapour and/or pollutants to the rest of the building. Extract ventilation may be intermittent or continuous

depending on the nature of the activities involved.

*Purge ventilation* applicable throughout the building to facilitate removal of high concentrations of pollutants or water vapour that may develop from time to time, e.g. from occasional activities such as painting and decorating and from accidental occurrences and spillages.

**1.1.9** The ventilation strategy adopted should ensure controllability so that the objectives set out in Paragraph 1.1.3 can be achieved without unreasonable waste of energy.

**1.1.10** Where a room or space contains a heat producing appliance, permanent ventilation opening may be required. See Technical Guidance Document J - Heat Producing Appliances.

**1.1.11** Regard shall also be had to the requirements of Part B of the Building Regulations - Fire Safety - when dealing with the provision of ventilation and air inlet openings.

**1.1.12** Noise generated by ventilation fans which may propagate through ducts and ductwork can disturb the occupants of a building and so discourage their use. Noise minimization should be considered through the specification of quieter products, the correct design of ductwork and fittings and installation and mounting of units to manufacturers instructions. Further Guidance is available in BS 8233 "*Sound Insulation and Noise Reduction for Buildings Code of Practice*".

**1.1.13** Consideration should be given to the ventilation strategy for buildings at the design stage of the construction to address issues such as health and safety, fire safety, noise and space requirements for equipment and ducting.

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## Glossary

**1.1.14** In this Document the following definitions apply

**Air permeability:** The average volume of air in cubic metres per hour that passes through one square metre of the building envelope when subject to an internal to external pressure difference of 50 Pascals when measured in accordance with the method defined in IS EN 13829:2000 “Thermal performance of buildings: determination of air permeability of buildings: fan pressurization method”. It is a measure of the resistance of the building envelope to *air infiltration*.

**Air infiltration:** The exchange of air between outside a building and inside other than through openings provided by design (for ventilation, access and other purposes). Infiltration is caused by pressure difference effects of wind and/or stack effect and occurs through cracks, porosity of building elements and other unintentional openings in the building fabric.

**Automatic control:** Control of a ventilation device, (e.g. opening, switching on or adjusting performance) by mechanical or electronic means in response to a relevant external stimulus, (e.g. humidity, pollutant level, occupancy detection, pressure difference).

**Background ventilator:** A secure ventilation opening generally located in a wall or window for the purpose of provision of general ventilation, generally incorporating a controllable ventilation grill which can be fully closed.

**Continuous operation:** A ventilation system that runs all of the time that ventilation is required, e.g. a mechanical ventilation system as the principal means of general ventilation. The performance level, e.g. airflow rate, may be adjusted manually or mechanically during operation.

**Equivalent area:** The area of a single sharp-edged hole that passes the same air volume flow rate at the same applied

pressure difference as the vent being tested. See Paragraph 1.1.15 regarding the *equivalent area of background ventilators* and the relationship between *equivalent area* and *free area* ventilation device under consideration.

**Extract ventilation:** Designed provision for the removal of air from a room or space directly to outside. Extract ventilation may be provided by natural means (e.g. passive stack ventilation) or by mechanical means (e.g. by an extract fan).

**Free area:** The geometric open area of a ventilator.

**General ventilation:** Ventilation of rooms and spaces at a relatively low continuous rate to control pollutant and water vapour levels to acceptable levels generally and provide adequate levels of fresh outdoor air.

**Habitable room:** A room in a dwelling used for living or sleeping purposes but does not include a kitchen having a floor area of less than 6.5 m<sup>2</sup>.

**Intermittent operation:** Operating when a particular need is identified. Intermittent operation may be in response to automatic control responding to a particular stimulus, or manual control when need identified by user.

**Kitchen:** Means a room or part of a room used primarily for the preparation and cooking of food.

**Manual control:** Control of a ventilation device, e.g. opening, switching on or adjusting performance, by manual intervention of user, e.g. dwelling occupant.

**Occupiable room:** A room in a building other than a dwelling, occupied as an office, workroom, classroom, hotel bedroom or similar room but does not include a bathroom, sanitary accommodation, utility room or rooms or spaces used solely or principally for circulation, building services, plant or storage purposes.



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**Passive stack ventilation (PSV):** A ventilation system using ducts from high level locations within rooms to terminals on or above the roof, which provides a flow of air by a combination of the natural stack effect, i.e. the movement of air due to the difference in temperature between inside and outside, and the effect of wind passing over the roof of the dwelling.

**Permanent ventilator:** A ventilator permanently fixed in the open position and not provided with a means of closure which eliminates airflow through the device.

**Purge ventilation:** Ventilation by means of a large adjustable ventilation opening or openings which will allow the movement of a substantial volume of air in a short time period e.g. an opening window or door, and with some part of the ventilation opening at least 1.75 m above the floor level [previously called "rapid ventilation"].

**Stack effect:** Airflow between inside and outside a building due to the pressure differential caused by differences in air density associated with indoor/outdoor air temperature differences.

**Utility room:** A room used for laundry purposes which contains a sink, washing machine, tumble drier or similar equipment and which is not entered solely from outside the building.

**Ventilation opening:** Any means of permanent or controllable ventilation which –  
- opens directly to the external air, and  
- except in the case of a screen, fascia, baffle, etc., has a smallest dimension of at least 8 mm, but does not include a flue to a chimney.

**Wet room:** A room used for domestic activities, e.g. cooking, clothes washing, bathing, which, by their nature, are likely to give rise to significant production of water vapour. Typical wet rooms in dwellings are kitchens, utility rooms, bathrooms and sanitary facilities containing provision for showering or bathing.

### **Equivalent area and Free area**

**1.1.15** In this document, opening areas for background ventilators are specified in terms of *equivalent area*. The *equivalent area* of a

ventilator is always less than the *free area* and is a better measure of the airflow performance of a ventilator. The more complex the airflow path through a ventilator, the greater the difference between *equivalent area* and *free area*. *Equivalent area* is measured in accordance with the method specified in IS EN 13141-1: 2004. Information on *equivalent area* of ventilation products, e.g. trickle ventilators, should be supplied by the product manufacturer. Where this information is not available, the free area may be used to assess compliance but the area of ventilator required should be increased by 25%.

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## 1.2 DWELLINGS

### 1.2.1 General

**1.2.1.1** In this Subsection guidance is given on approaches to meeting the ventilation objectives as set out in Subsection 1.1 through the use of

- a) natural ventilation with specific provision for extract ventilation (Subsection 1.2.2); and
- b) mechanical ventilation with heat recovery (Subsection 1.2.3).

In both cases provision for purge ventilation by openable windows or external doors is provided. *Diagrams 1 and 2* show the key characteristics of each approach.

Other approaches to ventilation provision may be adopted provided the requirements of Regulation F1 are met.

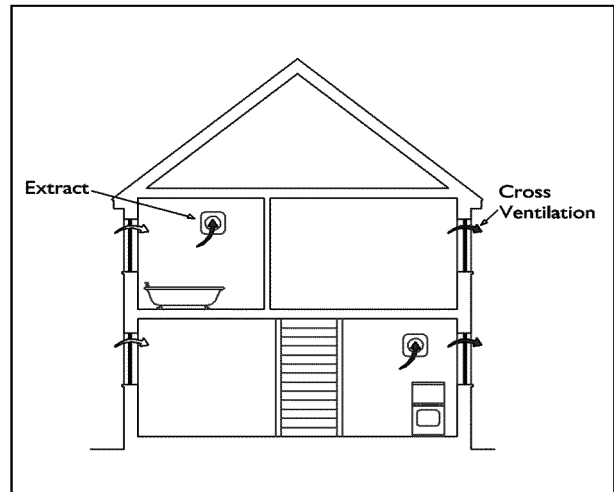
**1.2.1.2** Provision should be made to facilitate transfer of air and cross ventilation between rooms, e.g. a 10 mm gap should be provided under doors.

**1.2.1.3** Mechanical extract terminals, passive stack extract vents and extract fans should be placed as high as practical and no greater than 400 mm below ceiling level. Cooker hoods should generally be located 650 mm to 750 mm above the hob surface unless otherwise recommended by manufacturers.

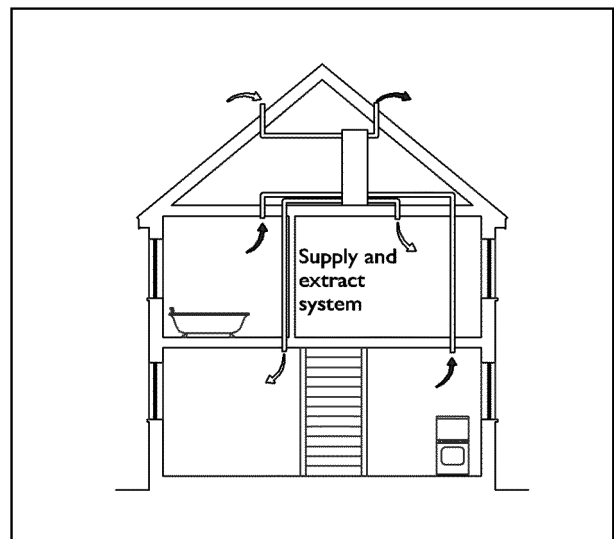
**1.2.1.4** Where ducting is provided e.g. for passive stack ventilation or for ventilation supply or extract, in dwellings with a protected stairway, particular regard must be had to the requirements of Part B of the Building Regulations to avoid the possibility of smoke or fire spreading into the stairway.

**1.2.1.5** Where ducting passes through a compartment wall or floor, the required measures to ensure compliance with Part B of the Building Regulations must be taken. Section 3.4 of TGD B Protection of Openings and Fire Stopping provide specific guidance for Ventilating Ducts and Fire-Stopping.

**Diagram 1: Natural Ventilation with mechanical extract**



**Diagram 2: Mechanical ventilation with heat recovery**



**1.2.1.6** Where both open flued combustion appliances (including open fires) and extract fans are installed in the same dwelling reduced rates of extraction may be appropriate in these circumstances. Reference should be made to BRE Information Paper 1P 7/94 *Spillage of flue gases from solid-fuel combustion appliances* and BRE Information Paper IP 21/92, *Spillage of flue gases from open-flued combustion appliances*. See also additional guidance in TGD J.

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**1.2.1.7** The installation of ductwork and fans affects safety, efficiency and integrity of ventilation systems. The guidance below should be followed:

- Fans and ducting placed in or passing through unheated voids or loft spaces should be insulated to reduce the possibility of condensation forming. Ducts should be insulated with the equivalent of at least 25 mm of insulating material with a thermal conductivity of .04W/mK. Insulation should be applied to both warm and cold air ducts. Cold air ducts should be wrapped additionally with a vapour barrier outside the insulation.

- Horizontal ducting, including ducting in walls, should be arranged to slope slightly downwards away from the fan to prevent backflow of any moisture into the product.

- All duct runs should be straight, with as few bends and kinks as possible to minimize system resistance.

- The use of rigid ductwork improves robustness and reduces risks of leaks. Use of flexible ductwork should be avoided and should only be used in very short lengths and mainly to connect rigid ductwork to diffusers/units or to overcome particular obstructions. All flexible ducting should be pulled taut to minimise system resistance. No peaks or troughs should occur in ductwork. The cross sectional area of the ductwork should be maintained throughout the full length of the duct run.

- All duct jointing, collars and components should be installed to ensure appropriate duct performance (duct runs should be as air tight as possible). All joints should be sealed using suitable sealants or tapes.

**1.2.1.8** Ceiling height is one of a number of factors which affects ventilation of habitable rooms. The suggested dimensions in *Diagram 3* are consistent with good room design, the use of standard materials and good building practice.

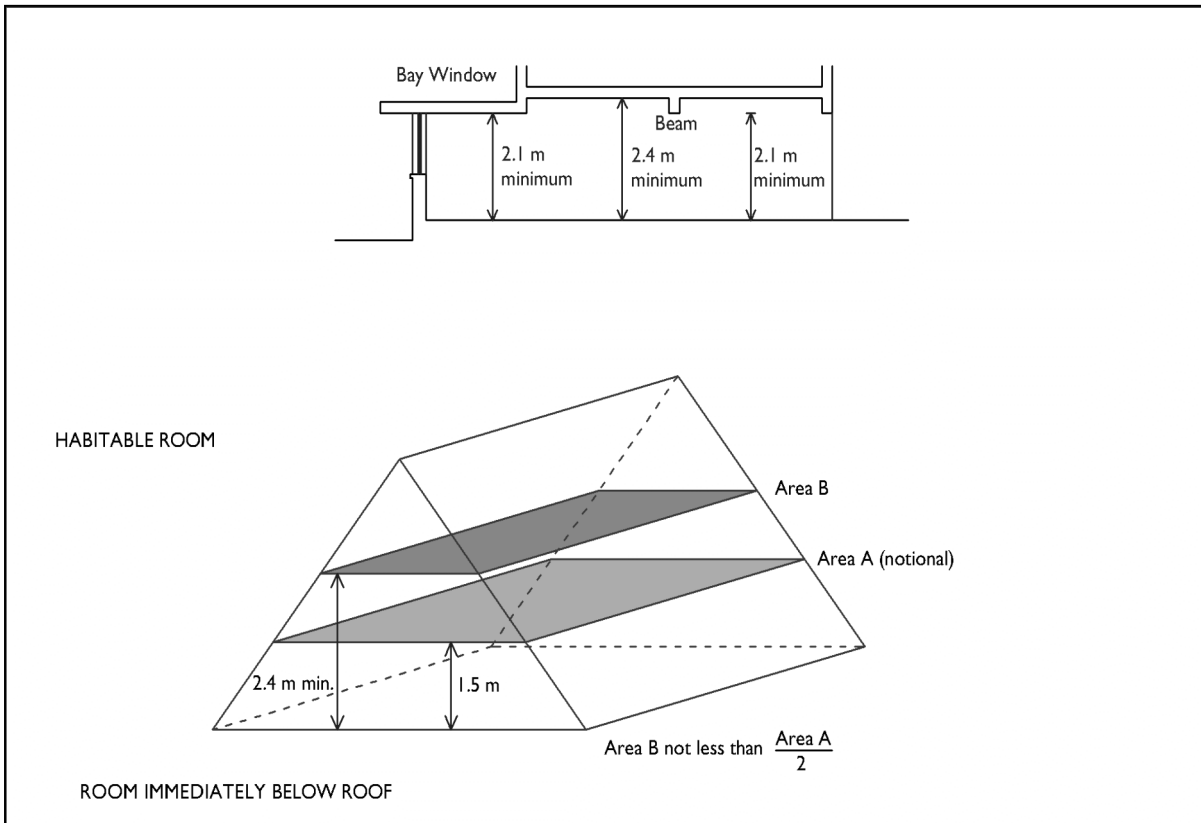
**1.2.1.9** Where background ventilators and individual fans are fitted in the same room

they should be a minimum of 0.5 m apart.

**1.2.1.10** Where a dwelling has more than one exposed façade, similar equivalent areas should be located on opposite or adjacent sides of the dwelling in order to maximize air flow through cross ventilation Ref. *Diagram 1*.

**1.2.1.11** Detailed information on the installation and commissioning of ventilation systems is provided in *Installation and Commissioning of Ventilation Systems for Dwellings-Achieving Compliance with Part F* (to be published).

**Diagram 3: Suggested height of habitable rooms**



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## 1.2.2 Natural Ventilation

### Ventilation Rates

**1.2.2.1** Where the air permeability is  $5\text{m}^3/(\text{h}\cdot\text{m}^2)$  or greater, the minimum total equivalent area of background ventilators providing general ventilation should be  $30,000\text{mm}^2$  with an additional  $5,000\text{mm}^2$  for each additional  $10\text{m}^2$  floor area above the first  $70\text{m}^2$  of floor area measured. For single storey dwellings situated at ground level or on any storey up to four storeys, an additional  $5,000\text{mm}^2$  per dwelling should be provided. Where air permeability is less than  $5\text{m}^3/(\text{h}\cdot\text{m}^2)$  all equivalent areas stated above should be increased by 40%. As noted in Paragraph 1.1.15, the areas specified should be increased by 25% where free area of ventilators is used instead of equivalent area. Example calculations are provided in Appendix 1.

**1.2.2.2** *Table 1* and *Diagram 4* summarise the provisions for general extract and purge ventilation appropriate for various spaces within a dwelling when natural ventilation is chosen as the primary means of ventilation. These are minimum provisions for each space. The whole house ventilation rate should be as calculated in Paragraph 1.2.2.1.

**1.2.2.3** For wet rooms, e.g. kitchens, utility rooms, bathrooms or rooms with sanitary facilities (without bath), where mechanical extract ventilation is provided and there is no provision for general ventilation by means of controllable background ventilator and no provision for purge ventilation by means of an openable window, the mechanical extract ventilation should include an automatic 15 minute overrun (after switchoff). In the case of a kitchen, utility room or bathroom without WC, control by humidistat is acceptable as an alternative to 15 minute overrun. Any automatic control should have a manual override to allow the occupant to turn the extract on. In kitchens any automatic control must provide sufficient flow during cooking with fossil fuel (e.g. gas) to avoid build-up of combustion products.

### Background ventilators

**1.2.2.4** Typical types and locations of background ventilators are illustrated in *Diagram 5*. Background ventilators should be located, as far as possible, so as to avoid draughts, e.g. more than 1.75 m above floor level. All background ventilators should be tested to EN 13141-1 and installed to manufacturers instructions.

**1.2.2.5** Manually controlled background ventilators may be used. Background ventilators that respond to pressure differential across the ventilator and automatically reduce opening area to adjust ventilation flowrate may also be used.

### Purge Ventilation

#### Windows (habitable rooms)

**1.2.2.6** For a hinged or pivot window that opens  $30^\circ$  or more, or for sliding sash windows, the height multiplied by the width of the opening part should be at least  $1/20^{\text{th}}$  of the floor area of the room.

For a hinged or pivot window that opens between  $15^\circ$  and  $30^\circ$ , the height multiplied by width of the opening part should be at least  $1/10^{\text{th}}$  of the floor area of the room.

If the room contains more than one openable window, the areas of all the opening parts may be added to achieve the required proportion of the floor area. The required proportion of the floor area is determined by the opening angle of the largest window in the room.

Refer to Part B /TGD B of the Regulations for minimum opening sizes required for escape.

#### External doors (including patio doors) (habitable rooms)

For an external door, the height x width of the opening part should be at least  $1/20^{\text{th}}$  of the floor area of the room.

If the room contains more than one external door, the areas of all the opening parts may be added to achieve at least  $1/20^{\text{th}}$  of the floor area of the room.

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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 1/20<sup>th</sup> of the floor area of the room.

### **Mechanical Extract Fans**

**1.2.2.7** Mechanical extract fans should be chosen to achieve the specified airflow rate having regard to location, length and type of ducting and size and type of discharge grille. Axial fans are normally only suitable for use with short length of through-the-wall ducting of the same size as the fan outlet. For bathrooms, axial fans may be acceptable for use with flexible ducting up to 1.5 m long and two 90° bends. Centrifugal fans can generally be used with flexible ducting of up to 3m and one 90° bend for extract rates of 60l/s (e.g. from kitchen) and up to 6m for extract rates of 15 l/s with two 90° bends (e.g. from bathrooms).

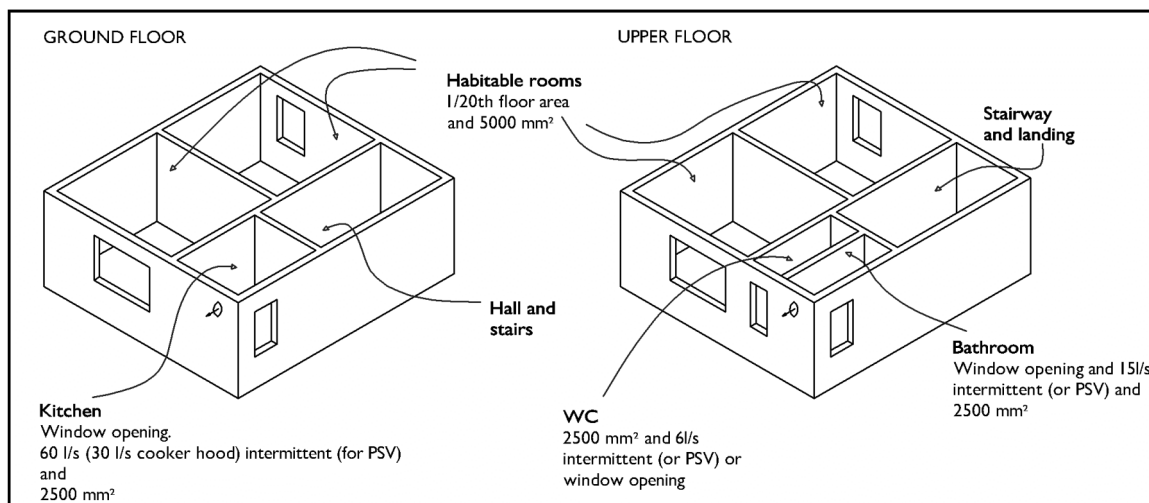
**1.2.2.8** The appropriateness of a particular fan for a particular use should be verified by reference to manufacturers data. The aerodynamic performance of extract fans should be established using the test methods specified in IS EN 13141-4. For cooker hoods the test methods are specified in IS EN 13141-5:2004.

<b>Table 1: Basic ventilation provision using background ventilators and specific provision for extract and purge ventilation</b>			
<b>Room or Space</b>	<b>General Ventilation</b>	<b>Extract ventilation</b>	<b>Purge ventilation</b>
	<b>Minimum equivalent area of background ventilator<sup>a</sup> (mm<sup>2</sup>)</b>	<b>Extract fan<sup>b</sup> - Minimum intermittent extract rate (l/s)</b>	<b>Opening window or external door - Minimum provision<sup>h</sup></b>
<b>Habitable Room</b>	5000 <sup>c, d, g</sup>	-	1/20th of room floor area
<b>Kitchen</b>	2500 <sup>c, d, e, g</sup>	60l/s generally 30l/s if immediately adjacent to cooker (e.g. cooker-hood not recirculating)	Window opening section (no size requirement) <sup>e</sup>
<b>Utility Room</b>	2500 <sup>c, d, e</sup>	30 l/s	Window opening section (no size requirement) <sup>e</sup>
<b>Bathroom</b>	2500 <sup>c, d, e</sup>	15 l/s	Window opening section (no size requirement) <sup>e</sup>
<b>Sanitary Accommodation (no bath or shower)</b>	2500 <sup>c, d, e</sup>	6 l/s <sup>f</sup>	Window opening section (no size requirement) <sup>e</sup>

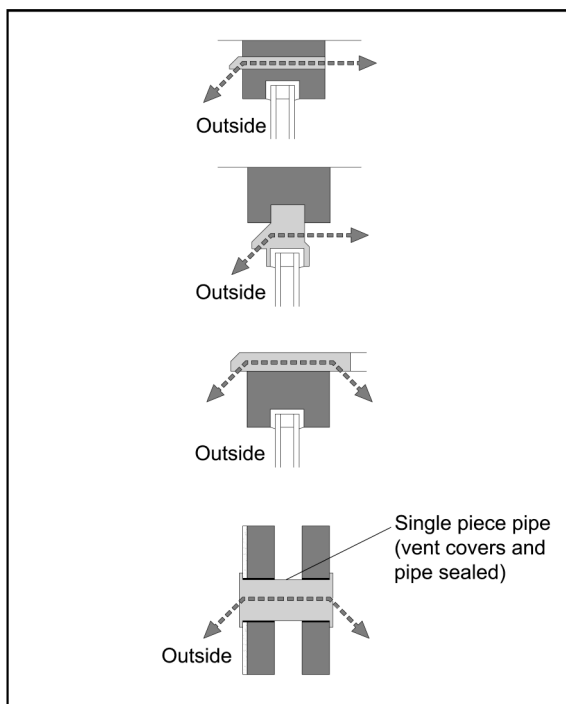
Notes:

- See paragraph 1.2.2.1 re: total equivalent area for all background ventilators.
- See paragraphs 1.2.2.9 and 1.2.2.10 re alternative of passive stack ventilation or continuous room ventilation with heat recovery.
- Equivalent areas to be increased by 40% where air permeability is less than 5m<sup>3</sup>/(h.m<sup>2</sup>).
- See paragraph 1.2.2.12 re the extent and location of background ventilation where there is only a single exposed façade and cross-ventilation is not possible.
- See paragraph 1.2.2.3 re ventilation provision where the provision of background ventilation and purge ventilation is not possible, e.g. when there is no external wall.
- As an alternative, the opening window section provided for purge ventilation may also be relied on for extract ventilation.
- See paragraphs 1.2.2.13 to 1.2.2.15 re: provision for ventilation of habitable rooms through other rooms or into courtyards.
- Opening window or external door minimum provisions given in this table are for ventilation purposes. Other requirements apply to the provision of openings for windows or external doors for example escape in case of a fire. Refer to Part B / TGD B for further guidance.

**Diagram 4: Ventilation of a typical dwelling**



**Diagram 5: Typical background ventilators**



### Alternative Systems

**1.2.2.9** In general, passive stack ventilation (PSV) may be used instead of mechanical extract in any location where an extract fan is specified in *Table 1*. Passive stack ventilation should be designed and installed in accordance with BRE IP 13/94 and, for kitchens and utility rooms, incorporate an automatic humidity sensitive ventilation inlet control grille (see also Paragraph 1.2.1.6). Background ventilators are not required where a PSV is located, but open-flued combustion appliances will still require an air supply as given in Technical Guidance Document J.

**1.2.2.10** A continuously operating single room heat recovery ventilator may also be used in any location where a mechanical extract fan is specified in *Table 1*. Such a ventilator should have a minimum high rate of extraction equivalent to the extract rate specified in *Table 1* and a minimum low rate

equivalent to 50% of this rate. This ventilator provides general ventilation and extract ventilation and neither a background ventilator nor an extract fan is required. For each single room heat recovery ventilator provided the total equivalent area of the background ventilators for the dwelling (see Paragraph 1.2.2.1) can be reduced by 2,500 mm<sup>2</sup>.

**1.2.2.11** Where a kitchen or utility room contains an open-flued appliance

- which is the main source of space heating or hot water heating for the dwelling, or
- which has a flue with a free area of at least the equivalent of a 125 mm diameter duct,

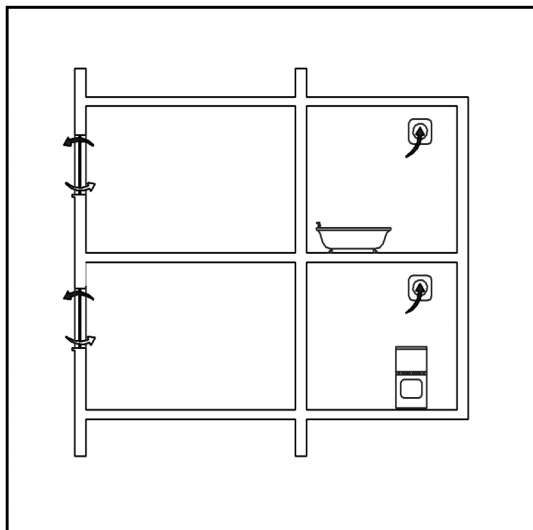
and both flue and air inlets are permanently open, i.e. with no control dampers, additional provision for extract ventilation e.g. by means of mechanical extract ventilation or passive stack ventilation, should not be necessary.

### Single sided ventilation

**1.2.2.12** The guidance given in *Table 1* relates to dwellings where a reasonable degree of cross ventilation is possible and background ventilators are located on opposite or adjacent sides. For a dwelling with a single exposed façade, e.g. an apartment with only one exposed side, natural ventilation may be provided by the use of high and low level background ventilators. The area of high level ventilators should be as set out in *Table 1* with an equivalent area of low level ventilators installed. There should be a difference in level of at least 1 metre between high and low level ventilators. Alternatively cross ventilation may be provided by the use of passive stack ventilators in wet rooms located away from the single exposed façade of the dwelling. *Diagram 6* summarises the type of provision appropriate when cross ventilation is not possible.



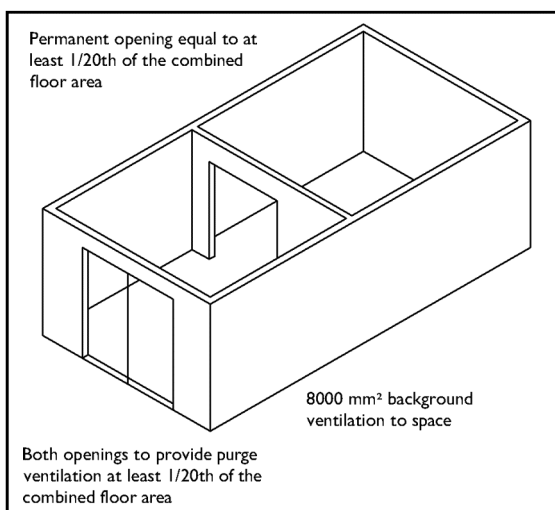
**Diagram 6: Single sided ventilation**



**Ventilation of Habitable Rooms through other rooms and spaces**

**1.2.2.13** Two habitable rooms may be treated as a single room for ventilation purposes if there is an area of permanent opening between them equal to at least 1/20th of the combined floor areas (see *Diagram 7*) and a wall or window ventilator having an equivalent area not less than 8,000 mm<sup>2</sup> and located so as to avoid undue drafts.

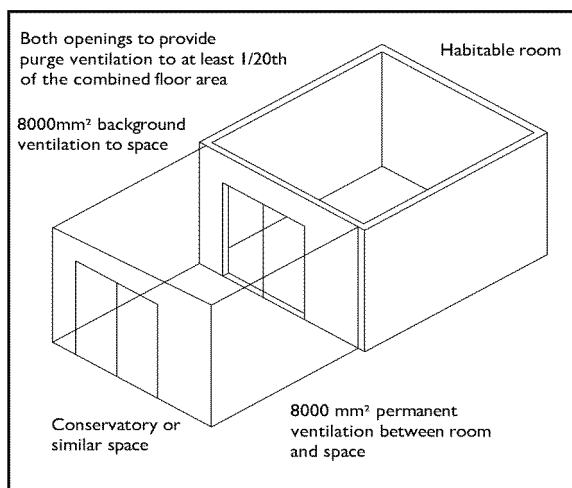
**Diagram 7: Two rooms treated as a single room for ventilation purposes**



**1.2.2.14** A habitable room may be ventilated through an adjoining space (see *Diagram 8*) if-

- a) the adjoining space is a conservatory or similar space, and
- b) there is an opening (which may be closeable) between the room and the space, with an area not less than 1/20th of the combined floor area of the room and space, and
- c) provision is made for-
  - (i) background ventilation to the space, and
  - (ii) one or more permanent openings for ventilation purposes between the room and the space consisting of a wall or window ventilator, each having an equivalent area not less than 8,000 mm<sup>2</sup> and located so as to avoid undue drafts, and
- (d) provision is made for purge ventilation to the space with a total area not less than 1/20th of the combined floor area of the room and space, and
- (e) the space is not connected to another room which has no alternative means of natural ventilation other than through the space, and
- (f) provision is made for mechanical extract or passive stack ventilation if the room contains a kitchen.

**Diagram 8: A habitable room ventilated through an open space**



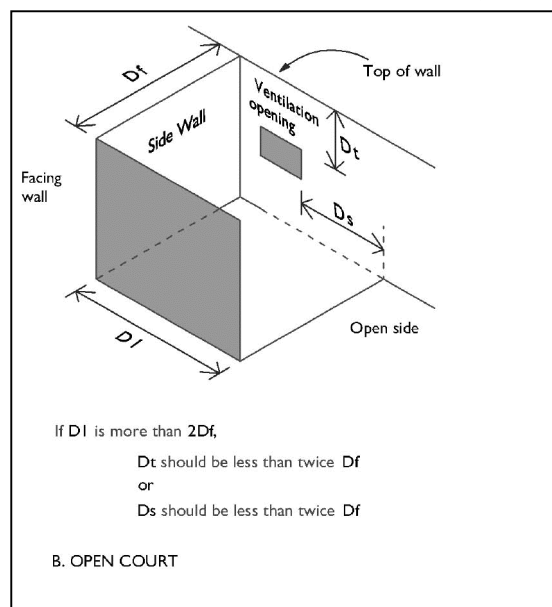
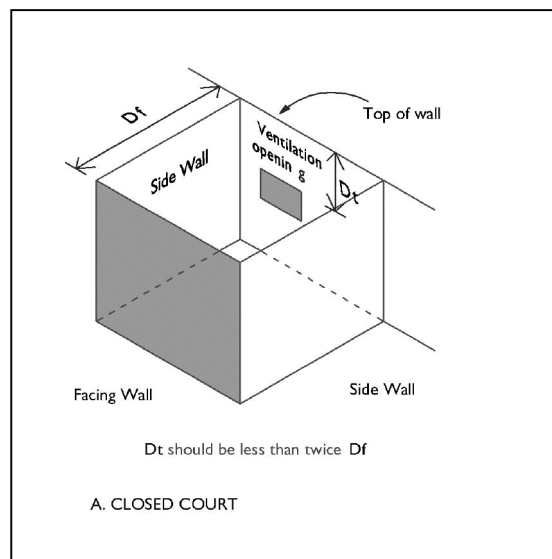
### Ventilating to a Court

**1.2.2.15** Where a building contains a court and a ventilation opening serving a habitable room in a dwelling faces a wall nearer than 15 m, the following minimum distances should be maintained:

- (a) if there is a wall on each side of the opening (forming a closed court) (see *Diagram 9A*), then the vertical distance from the top of the opening to the top of the wall containing the opening,  $D_t$ , should be less than twice the horizontal distance from the opening to the facing wall,  $D_f$ , or
- (b) if there is a wall on only one side of the opening (forming an open court) (see *Diagram 9B*), and if the length of the facing wall,  $D_l$ , is more than twice the horizontal distance from the opening to the facing wall,  $D_f$ , then either -
  - (i) the vertical distance from the top of the opening to the top of the wall containing the opening,  $D_t$ , or
  - (ii) the horizontal distance from the side of the opening to the open side of the court,  $D_s$ ,

should be less than twice the horizontal distance from the opening to the facing wall,  $D_f$ .

**Diagram 9: Ventilation of a habitable room to an enclosed court**



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### 1.2.3 Mechanical Ventilation with Heat Recovery (MVHR)

**1.2.3.1** A Mechanical Ventilation with Heat Recovery system should be capable of providing adequate general ventilation at all times and of meeting requirements for extract ventilation that may need to be met from time to time.

**1.2.3.2** The minimum capacity of a Mechanical Ventilation with Heat Recovery system should be based on the calculated general ventilation rate, adjusted to allow for air infiltration due to permeability of the building fabric. The calculated general ventilation rate is determined as the greater of

a) 5 l/s plus 4 l/s per person, e.g. 25 l/s for a five person dwelling. This is based on two occupants in the main bedroom and a single occupant in all other bedrooms.

This should be used as the default value if a greater level of occupancy is expected, then add 4 l/s per occupant.

Or

b) 0.3 l/s per m<sup>2</sup> internal floor area, e.g. 30 l/s for a 100 m<sup>2</sup> dwelling.

The adjustment to the calculated general ventilation rate to allow for air infiltration is 0.04V (l/s), where V is the gross internal volume of the dwelling in m<sup>3</sup>.

Where the air permeability is 5m<sup>3</sup>/(h.m<sup>2</sup>) or greater, the adjustment is deducted from the calculated general ventilation rate to give the minimum capacity of the Mechanical Ventilation with Heat Recovery system.

Where the air permeability is less than 5m<sup>3</sup>/(h.m<sup>2</sup>) no deduction is made.

Example calculations are given in Appendix 1.

**1.2.3.3** In order to meet extract requirements, the system may require a higher extract or boost capacity depending on the number of wet rooms (kitchens, bathrooms, etc.). The extract rate to be provided for each wet room is specified in *Table 2*. The required overall extract rate is calculated by adding together the relevant individual extract rates specified in the Table.

**1.2.3.4** The maximum rate (boost rate) should be at least the greater of the minimum ventilation rate (as calculated in Paragraph 1.2.3.2) and the overall extract rate (as calculated in Paragraph 1.2.3.3).

The minimum rate should be at least the minimum capacity (as calculated in Paragraph 1.2.3.2).

**Table 2: MVHR Systems: Minimum extract rates**

Wet rooms	Minimum extract rate (l/s)
Kitchen	13
Utility room	8
Bathroom	8
Sanitary accommodation (no bath or shower)	6 <sup>1</sup>

Notes:

1. As an alternative, an opening window provided for purge ventilation may be relied on for extract.

**1.2.3.5** A Mechanical Ventilation with Heat Recovery system should normally provide air supply to each habitable room with extract from wet rooms. The system should be capable of an extract rate from each wet room at least equal to that specified in *Table 2*. It is not recommended to connect cooker hoods to Mechanical Ventilation with Heat Recovery systems. Where cooker hoods are connected the guidance under fire precautions in BRE Digest 398 "*Continuous mechanical ventilation in dwellings*" should be followed.

**1.2.3.6** Facility for purge ventilation should be provided where the general and extract ventilation is provided by a Mechanical Ventilation with Heat Recovery system. Purge ventilation provision should be as set out in *Table 1* for natural ventilation.

**1.2.3.7** MVHR systems should achieve a leakage classification of Class 2 or better as defined in IS EN 13141-7 when tested in accordance with the standard. Detailed guidance on the relevant test procedure is contained in "*Performance testing of products for residential ventilation - Central mechanical supply and exhaust ventilation system packages with heat recovery used in a single*

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*dwelling*” which is the approved procedure for DEAP.

**1.2.3.8** Open flued combustion appliances are not recommended in dwellings fitted with Mechanical Ventilation with Heat Recovery where the system might interfere with the operation of the appliance and combustion. All extract points should be treated as if they were extract fans. Further guidance is available in BRE 398 “*Continuous Mechanical Ventilation in Dwellings: design, installation and operation*”.

**1.2.3.9** Guidance for ductwork installation is provided in Paragraph 1.2.1.7. In addition installed heat recovery units should be:

- Insulated to minimise heat loss,
- Fixed to a stable element of the building (e.g. floor or wall) using manufacturer recommended / supplied fixings,
- Have condensate drains fitted and pipe insulated,
- Have suitable acoustic/anti-vibration mountings and
- Ductwork connection to unit should be such that vibration is not transmitted to duct joints.

**1.2.3.10** Units should be installed so that the occupant can easily access them for routine and regular cleaning of filters.

**1.2.3.11** It is important that the occupier of a home understands the importance of the use and operation of a Mechanical Ventilation with Heat Recovery system. These units should be run continuously and operated and maintained in accordance with manufacturers instructions.

Further information on installation, operation and maintenance of these systems is given in BRE Digest 398 “*Continuous mechanical ventilation in dwellings: design installation and operation*” and *Installation and Commissioning of Ventilation Systems for Dwellings- Achieving Compliance with Part F* (to be published).

**1.2.3.12** Controls for Mechanical Ventilation with Heat Recovery systems should be suitable for continuous operation and should provide indication to the occupant that the system is operating correctly. Controls should also indicate if a fault has occurred

on the system and if maintenance is required.

**1.2.3.13** The Mechanical Ventilation with Heat Recovery system should be commissioned so that at completion the system and its controls are left in the intended working order and can operate efficiently and effectively. Checks should be performed on ductwork installation, unit fixing, electrical connection, system balancing and calibration.

Airflow measurements should be performed using a calibrated airflow device with an appropriate hood attachment and results recorded in litres per second (l/s). Actual flowrates should meet design flowrates as calculated using Paragraphs 1.2.3.2 to 1.2.3.4.

Further information on commissioning is available in *Installation and Commissioning of Ventilation Systems for Dwellings- Achieving Compliance with Part F* (to be published).

**1.2.3.14** The owner of the building should be provided with sufficient information about the Mechanical Ventilation with Heat Recovery, its operation and maintenance requirements so that it can be operated in an efficient and effective manner. A way of complying would be to provide a suitable set of operating and maintenance instructions on the Mechanical Ventilation with Heat Recovery system in a way the householder can understand. The instruction should be directly related to the system installed in the dwelling without prejudice to the need to comply with health and safety regulations. The instructions should explain the important function of the system to provide adequate ventilation, how the system is intended to work, why the system should not be turned off, how the controls should be used and how and when the system should be cleaned and maintained. Cleaning of filters should be clearly explained in this document. The location of the Mechanical Ventilation with Heat Recovery unit in the dwelling and the location of filters on the unit should be identified in the document. An explanation of how to remove the filters from the unit and clean them should be provided. The frequency of cleaning of filters should also be clearly stated in this document.

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Boost and normal operation of the unit should be explained and the effects of opening windows. Guidance on the operation of controls and how a fault is indicated should also be included.

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## BUILDINGS OTHER THAN DWELLINGS

### 1.3.1 General

**1.3.1.1** In this Subsection guidance is given on approaches to meeting the ventilation objectives as set out in Subsection 1.1 for:

- a. Offices in Paragraphs 1.3.2.1 to 1.3.2.9
- b. Car parks in Paragraph 1.3.3.1

For other buildings guidance can be found in CIBSE Guide B and other relevant guidance documents.

**1.3.1.2** Other means of ventilation other than those specified in this document may be used provided the requirements of Regulation F1 are met.

**1.3.1.3** Certain types of buildings such as offices, shops, factories, etc. may be subject to specific legislative requirements. The relevant legislation should be consulted.

**1.3.1.4** Specific requirements of the Safety, Health and Welfare at Work (General Application) Regulations 2007 should be consulted.

**1.3.1.5** Where ductwork is provided particular regard must be had to the requirements of Part B of the Building Regulations to avoid the possibility of smoke or fire spread.

#### Design of ventilation systems

**1.3.1.6** Extract to outside should be provided in all office sanitary accommodation, washrooms and in food and beverage preparation areas. In addition printers and photocopiers in substantial use (greater than 30 minutes per hour) should be located in a separate room (to avoid any pollutants entering the occupied space) and extract provision installed. The extract rates should be no less than that specified in *Table 3*.

**1.3.1.7** A general ventilation rate of 10l/s per occupant for buildings is appropriate where

there are no significant pollutant levels. This rate is based on controlling body odours with low levels of other pollutants. Where there are significant levels of other pollutants, adequate outdoor air supply can be achieved by following the calculation method provided in CIBSE Guide A.

**1.3.1.8** Purge ventilation should be sufficient to reduce pollutants to an acceptable level before a space is occupied. The purged air should be taken directly to outside and should not be recirculated to any other part of the building.

**1.3.1.9** Where a kitchen, bathroom, sanitary accommodation or photocopier room is an internal room, it shall have mechanical extract ventilation to extract air at a rate of not less than that given in *Table 3*, and a permanently open air inlet having a clear equivalent area of at least 7,000 mm<sup>2</sup>.

**1.3.1.10** Provision should be made to protect the fresh air supplies from contaminants injurious to health. Air inlets for ventilation systems should not be sited where they may draw in excessively contaminated air (for example, close to a flue, an exhaust ventilation system outlet, an evaporative cooling tower or an area in which vehicles manoeuvre). For further information refer to TGD J for positioning of flue outlets in relation to ventilation openings.

**1.3.1.11** To avoid legionella contamination, cooling towers should be positioned as far away as possible from air conditioning and ventilation inlets, opening windows and occupied areas, taking note of the prevailing wind direction and the wind distribution over neighbouring buildings. Further guidance may be found in CIBSE TM13: *Minimising the risk of Legionnaires' disease*.

**1.3.1.12** Where a forced ventilation system is used it should be maintained in working order and any breakdown should be indicated by a control system if necessary for the safety and health of employees.

**1.3.1.13** Where an open flued combustion appliance is installed in a building with mechanical extract, the spillage of flue gases could occur. Reduced rates of extraction may be appropriate in these circumstances. It should be verified that the combustion appliance can operate effectively and safely whether or not the fans are running. Reference should be made to BRE Information Paper IP 7/94 *Spillage of flue gases from solid fuel combustion appliances* and BRE Information paper IP 21/92, *Spillage of flue gases from open-flued combustion appliances*. See also additional guidance in TGD J.

**1.3.1.14** Reasonable provision for access for maintenance in ventilation systems should be provided, including:

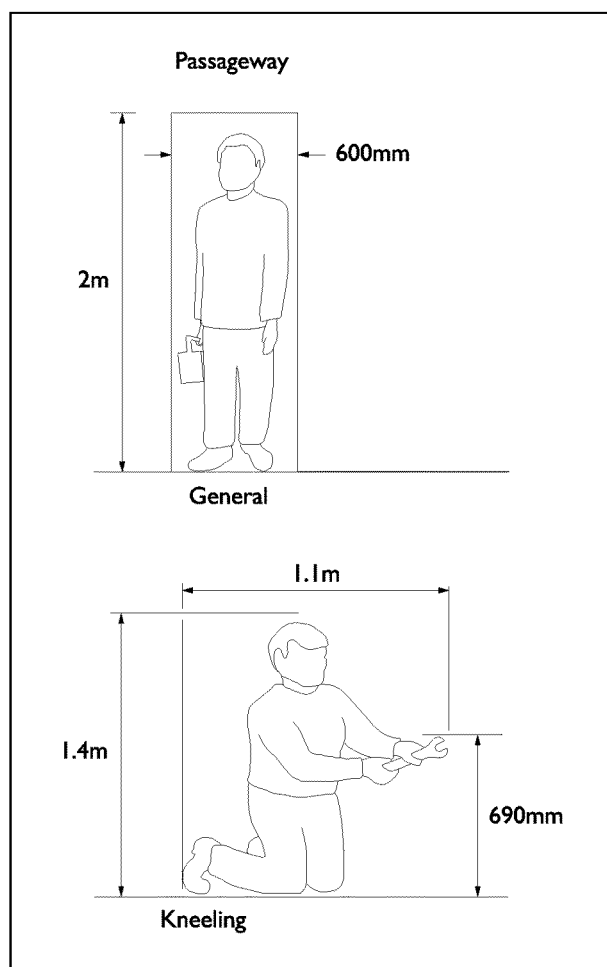
- i. Access for the purpose of replacing filters, fans and coils; and
- ii. Provision of access points for cleaning ductwork.

Further guidance on access is given in CIBSE Guide B *“Heating, ventilation, air conditioning and refrigeration”* Appendix 3.A2.

**1.3.1.15** Guidance with regards to the installation of ductwork is provided in Paragraph 1.2.1.7.

**1.3.1.16** In a central plant room adequate space should be provided as necessary for the maintenance of the plant. Where no special provision is required, the requirement should be satisfied if 600 mm space is provided where access is required between plant and 1,100 mm where space for routine cleaning is required (see *Diagram 10*). These figures represent minimum dimensions and additional space may be needed for opening of access doors withdrawal of filters etc. Further guidance for the cleaning of ducts is provided by CIBSE Ventilation Hygiene Toolkit.

**Diagram 10: Basic access space requirements**



### Commissioning

**1.3.1.17** Ventilation and air-conditioning systems should be commissioned and tested at completion so that the systems and their controls are left in the intended working order and can operate effectively and efficiently. A way of demonstrating compliance would be to commission and test in accordance with the CIBSE commissioning codes in order to verify that the systems perform in accordance with the specification.

### User Information

**1.3.1.18** The owner of the building should be provided with sufficient information about the ventilation systems and their maintenance so

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that an effective and an efficient ventilation system can be operated and maintained.

### **1.3.2 Ventilation of Offices**

**1.3.2.1** Adequate provision for ventilation rates as described in this subsection can be achieved through the use of:

- i. Natural ventilation with specific provision for extract ventilation,
- ii. Mechanical ventilation,
- iii. Air conditioning systems, or
- iv. Mixed mode ventilation.

#### **Natural ventilation with extract ventilation**

**1.3.2.2** For single-sided offices of depths of less than 6m and cross ventilated offices of depth less than 12m ventilation rates should be in accordance with Table 3.

**1.3.2.3** Manually controlled background ventilators may be used. Background ventilators that respond to pressure differential across the ventilator and automatically reduce opening area to adjust ventilation flowrate may also be used. Ventilators should be located and tested as per Paragraph 1.2.2.4

**1.3.2.4** For other office buildings adequate provision using natural ventilation may be achieved by following the guidance on the design of natural ventilation systems in CIBSE Application Manual AM10: *Natural ventilation in non-domestic buildings* .

**1.3.2.5** Extract ventilators should be located as high as possible and no greater than 400 mm below the ceiling.

**1.3.2.6** Extract fans may be controlled either manually or automatically. For a room with no openable window (i.e. an internal room), the extract should have a 15 minute over-run. Readily accessible over-ride controls should be provided for the occupants.

**1.3.2.7** Passive Stack Ventilation (PSV) may be used instead of mechanical extract where appropriate. It should be either operated manually and/or automatically by a sensor or controller. Readily accessible over-ride

controls should be provided for the occupants. Further information is available in CIBSE

Application Manual AM10: *Natural ventilation in non-domestic buildings*.

**1.3.2.8** Passive stack ventilator extract terminals should be located in the ceiling of the room.

#### **Alternative approaches**

**1.3.2.9** Ventilation by means other than natural ventilation may meet the requirement by following the relevant recommendations of: CIBSE Application Manual AM13: 2000: *Mixed Mode Ventilation*, CIBSE Guide A and CIBSE Guide B.



**Table 3: Basic ventilation provision using background ventilators and specific provision for extract and purge ventilation**

Room or Space	General ventilation	Extract ventilation <sup>(a)(b)(c)</sup>	Purge ventilation
	Minimum equivalent area of background ventilator (mm <sup>2</sup> )	Extract fan-minimum intermittent extract rate (l/s)	Opening window or external door-minimum provision
<b>Occupiable room</b>	(i) Floor area up to 10 m <sup>2</sup> – 5,000 mm <sup>2</sup> (ii) Floor area over 10 m <sup>2</sup> – 500 mm <sup>2</sup> /m <sup>2</sup> floor area	—	1/20 <sup>th</sup> of floor area
<b>Food and beverage preparation areas (not commercial kitchens)<sup>(d)(f)</sup></b>	(i) Floor area up to 10m <sup>2</sup> – 5,000 mm <sup>2</sup> (ii) Floor area over 10 m <sup>2</sup> – 500 mm <sup>2</sup> /m <sup>2</sup> floor area	Intermittent air extract rate of: 30 l/s above a hob with cooker(s) <sup>(e)</sup> 60l/s elsewhere with cooker(s) All to operate while food and beverage preparation is in progress	1/20 <sup>th</sup> of floor area
<b>Office sanitary accommodation (and/or washing facilities)<sup>(f)</sup></b>	(i) Floor area up to 10m <sup>2</sup> – 5,000mm <sup>2</sup> (ii) Floor area over 10 m <sup>2</sup> – 500 mm <sup>2</sup> /m <sup>2</sup> floor area	Intermittent extract rate of 15 litres/second per bath/shower 6 litres/second per WC/Urinal	1/20 <sup>th</sup> of floor area
<b>Rooms containing printers and photocopiers in substantial use (greater than 30 minutes per hour)<sup>(f)</sup></b>	(i) Floor area up to 10m <sup>2</sup> – 5,000 mm <sup>2</sup> (ii) Floor area over 10 m <sup>2</sup> – 500 mm <sup>2</sup> /m <sup>2</sup> floor area	Air extract rate of 20 l/s per machine during use. Note that if the operators are in the room continuously, use the greater of the extract and general ventilation rates as in Paragraph 1.3.1.7	1/20 <sup>th</sup> of floor area

- a. Where an open-flued appliance is provided in a building with mechanical extract ventilation, the spillage of flue gases could occur. The open-flued appliance needs to be able to operate safely whether or not the fan is running and guidance is provided in Paragraph 1.3.1.13.
- b. PSV may also be used to achieve this extract rate.
- c. Extract rate is for installed performance.
- d. Further guidance on the ventilation required for commercial kitchens is given in CIBSE Guide B 2.3.6. Table B2.3 and B2.
- e. Incorporated within a cooker hood.
- f. For internal rooms a permanently open air inlet having a clear equivalent area of at least 7,000 mm<sup>2</sup> should be provided. Extract fan overruns should be provided as per Paragraph 1.3.2.6.

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### 1.3.3 Ventilation of car parks

**1.3.3.1** The following approaches should be used for car parks below ground level, enclosed type car parks and multi-storey car parks:

i. **Naturally ventilated car parks.**

The provision of well distributed permanent natural ventilation e.g. openings at each car parking level with an aggregate equivalent area equal to at least  $1/20^{\text{th}}$  of the floor area at that level, of which at least 25% should be on each of two opposing walls.

ii. **Mechanically ventilated car parks**

Either:

- a) The provision of both permanent natural ventilation openings of equivalent area not less than  $1/40^{\text{th}}$  of the floor area and a mechanical ventilation system capable of at least three air changes per hour (ach); or
- b) For basement car parks, the provision of a mechanical ventilation system capable of at least six air changes per hour (ach);

In addition:

For exits and ramps where cars queue inside the building with engines running, provisions should be made to ensure a local ventilation rate of at least 10 air changes per hour (ach).

Further guidance can be found in CIBSE Guide B. For fire safety refer to TGD B.

#### **Alternative approaches**

**1.3.3.2** Other ventilation systems may meet the requirement for car parks below ground level, enclosed type car parks and multi-storey car parks by limiting the mean predicted pollutant levels of the concentration of carbon monoxide to not more than 30 parts per million averaged over an 8 hour period and peak concentrations such as by ramps and exits, not more than 90 parts per million for periods not exceeding 15 minutes.

# Section 2

## Condensation in Roofs

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Condensation in roofs.	F2	Adequate provision shall be made to prevent excessive condensation in a roof or in a roof void above an insulated ceiling.
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### 2.1 General

**2.1.1** Condensation in a roof and in the spaces above insulated ceilings should be limited so that, under normal conditions

- (a) the thermal performance of the insulating materials, and
- (b) the structural performance of the roof construction

will not be substantially and permanently reduced.

**2.1.2** The traditional method of limiting condensation in roof spaces is through the provision of adequate ventilation for cavities or attic spaces on the cold side of the roof insulation. Alternatively, where such cavities or spaces are absent, an effective vapour barrier is provided on the warm side of the insulation so that vapour from the building cannot permeate the insulation. Paragraphs 2.1.3 to 2.1.19 give some guidance on good practice in relation to non-complex buildings of normal design and construction, where the primary mechanism for achieving the limitation of condensation is the ventilation of roof voids or cavities. Effective limitation of condensation can also be achieved by other means including the use of vapour permeable or breathable roofing membranes. Where such methods are used, regard should be had to the requirements of Part D of the Building Regulations with regard to the use of proper materials and the guidance given in the Technical Guidance Document to Part D in that regard.

**2.1.3** Roofs where the moisture from the building can permeate the insulation, e.g. cold deck roofs, should be ventilated in accordance with Paragraphs 2.1.10 to 2.1.13 or in accordance with Paragraphs 2.1.14 to 2.1.18 depending on the roof type and slope.

**2.1.4** In addition to ensuring adequate ventilation, transfer of water vapour to cold roof voids should be limited as far as practicable. Care should be taken to seal around all penetrations of pipes, ducts, wiring, etc., through the ceilings, including provision of an effective seal to the attic access hatch.

Use of a vapour control layer at ceiling level, on the warm side of the insulation, will assist in limiting vapour transfer, but cannot be relied on as an alternative to ventilation. In particular, a vapour control layer should be used where the roof pitch is less than 15°, or where the shape of the roof is such that there is difficulty in ensuring adequate ventilation, e.g. room-in-the-roof.

For the purposes of health and safety, it may not always be necessary to provide ventilation to small roofs such as those over porches and bay windows.

**2.1.5** Roofs where the moisture from the building cannot permeate the insulation e.g. warm deck roofs or inverted roofs, need not be ventilated.

**2.1.6** Guidance is given for pitched roofs with a pitch greater than 15° in Paragraphs 2.1.10 to 2.1.13. Guidance is given for flat roofs and pitched roofs with a pitch less than 15° in Paragraphs 2.1.14 to 2.1.19. However, if the ceiling of a room follows the pitch of the roof, ventilation should be provided as if it were a flat roof, irrespective of the slope of the roof.

**2.1.7** Although a part of a roof which has a pitch of 70° or more may be insulated as though it were a wall (see Technical Guidance Document L), Requirement F2 applies to roofs of any pitch.

**2.1.8** Ventilation openings may be continuous or distributed along the full length of the eaves and may be fitted with a screen, fascia, baffle, etc.

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**2.1.9** Further guidance in relation to condensation in roofs is contained in BS 5250: 2002: *Code of Practice for Control of Condensation in Buildings*. Additional guidance is given in DEHLG publication *Acceptable Construction Details* and the BRE publication *"Thermal Insulation - avoiding risks"*.

### **Roofs with a pitch of 15° or more (Pitched Roofs)**

**2.1.10** If the ceiling follows the pitch of the roof, see Paragraphs 2.1.14 to 2.1.19.

**2.1.11** Pitched roof spaces should have ventilation openings at eaves level to promote cross-ventilation.

These openings should have an area on opposite sides at least equal to continuous ventilation running the full length of the eaves and 10 mm wide (see *Diagram 11(a)*).

**2.1.12** Purpose-made components are available to ensure that quilt or loose fill insulation will not obstruct the flow of air where the insulation and the roof meet.

**2.1.13** A pitched roof which has a single slope and abuts a wall should have ventilation openings at eaves level and at high level. The ventilation at high level may be arranged at the junction of the roof and the wall or through the roof covering. If it is through the roof covering, it should be placed as high as practicable. The area at high level should be at least equal to continuous ventilation running the full length of the junction and 5 mm wide (see *Diagram 11 (b)*).

### **Roofs with a pitch of less than 15° and roofs of any pitch where the ceiling follows the pitch of the roof**

**2.1.14** Roof spaces should have ventilation openings in two opposite sides to promote cross ventilation.

These openings should have an area at least equal to continuous ventilation running the full

length of the eaves and 25 mm wide (see *Diagram 11(c)*).

**2.1.15** Roofs with a span exceeding 10 m, or with a plain shape other than a simple rectangle, may require its ventilation to be increased to 0.6% of the roof area.

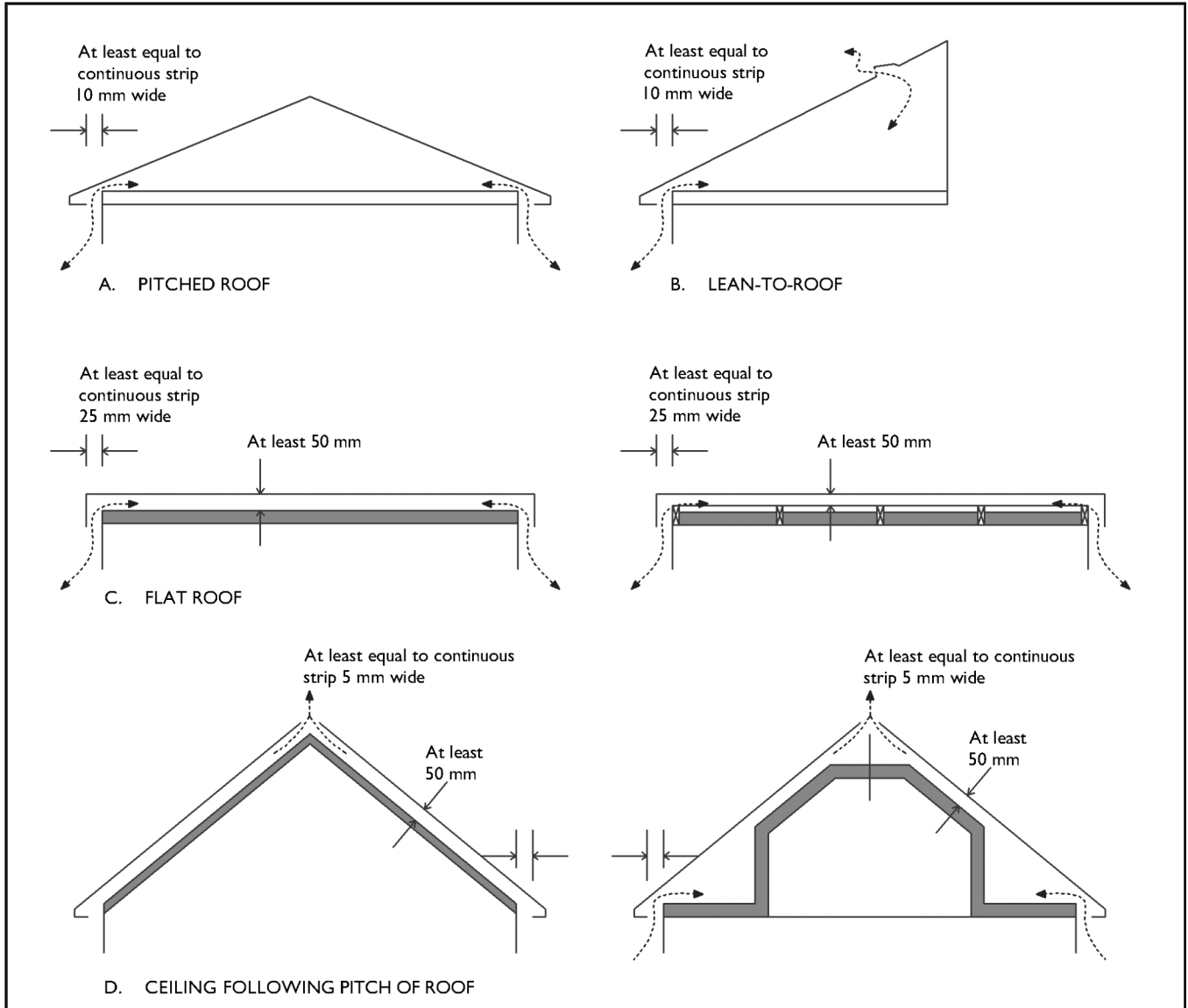
**2.1.16** The void should have a free air space of at least 50 mm between the roof deck and the insulation. Where joists run at right angles to the flow of air, a suitable air space may be formed by using counter battens.

**2.1.17** Where the insulation follows the pitch of the roof, ventilation at the ridge, at least equal to continuous ventilation running the length of the ridge and 5 mm wide, is also needed (see *Diagram 11(d)*).

**2.1.18** Where the edges of the roof abut a wall or other obstruction in such a way that free air paths cannot be formed to promote cross ventilation, or the movement of air outside any ventilation openings would be restricted, an alternative form of roof construction should be adopted (see Paragraph 2.1.5).

**2.1.19** A vapour control layer on the warm side of the insulation should generally be installed in the case of flat roof and roofs with a pitch of 15° or less.

**Diagram 11: Ventilating roof voids**



# Appendix 1 - Examples

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Examples 1 to 3 show sample calculations for general rate for an example house for natural ventilation and MVHR. Maximum boost rate calculations are also included for MVHR. Calculations are performed for an air permeability greater than  $5\text{m}^3/(\text{h.m}^2)$  and less than  $5\text{m}^3/(\text{h.m}^2)$ .

## **Example 1 – Background ventilation for $130\text{m}^2$ Two-Storey Semi-detached House, Air Permeability $> 5\text{m}^3/(\text{h.m}^2)$**

3 Bedrooms, 1 bathroom, 1 Utility, 1 Sitting room, 1 Kitchen, 1 Dining room, 1 Downstairs WC  
Wholehouse ventilation rate =  $30,000\text{mm}^2 + 5,000\text{mm}^2$  per  $10\text{m}^2 > 70\text{m}^2$   
 $130\text{m}^2 - 70\text{m}^2 = 60\text{m}^2$ . Therefore wholehouse background equivalent area reqd. =  $30,000 + (6 \times 5,000) = 60,000\text{mm}^2$ .  
Similar equivalent areas of vents should be distributed on opposite sides of the dwelling to maximize cross ventilation. For example this can be distributed through house as follows:  
Habitable rooms =  $5 \times 8,000\text{mm}^2$   
Bathroom, Utility, Kitchen, Downstairs WC =  $4 \times 5,000\text{mm}^2$

## **Example 2 – Background ventilation for $130\text{m}^2$ Two-Storey Semi-detached House, Air Permeability $< 5\text{m}^3/(\text{h.m}^2)$**

3 Bedrooms, 1 bathroom, 1 Utility, 1 Sitting room, 1 Kitchen, 1 Dining room, 1 Downstairs WC, 1 Internal Ensuite  
Wholehouse ventilation rate =  $(30,000 \times 1.4) = 42,000\text{mm}^2 + 7,000\text{mm}^2$  per  $10\text{m}^2 > 70\text{m}^2$   
 $130\text{m}^2 - 70\text{m}^2 = 60\text{m}^2$ . Therefore wholehouse background equivalent area reqd. =  $42,000 + (6 \times 7,000) = 84,000\text{mm}^2$ .  
Similar equivalent areas of vents should be distributed on opposite sides of the dwelling to maximize cross ventilation. For example this can be distributed through house as follows:  
Habitable rooms =  $5 \times 10,000\text{mm}^2$   
Bathroom, Utility, Kitchen, Downstairs WC =  $4 \times 8,500\text{mm}^2$

## **Example 3 – MVHR for $130\text{m}^2$ Semi-detached House, Air Permeability $< 5\text{m}^3/(\text{h.m}^2)$**

3 Bedrooms, 1 bathroom, 1 Utility, 1 Sitting room, 1 Kitchen, 1 Dining room, 1 Downstairs WC, 1 Internal Ensuite  
Minimum Ventilation rate  
General ventilation rate is the greater of 5l/s plus 4l/s person i.e.  
 $5\text{l/s} + (4\text{l/s} \times 4) = 21\text{l/s}$  (Assume 2 people in main bedroom and 1 in each other bedroom)

Or

$0.3\text{l/s/m}^2$  means the minimum ventilation will be  $(0.3 \times 130) = 39\text{l/s}$   
 $39\text{l/s}$  is the greater of the above 2 calculations and is the minimum required ventilation rate.

Maximum rate (boost rate) from Table 2.  
 $(1 \times 13) + (1 \times 8) + (2 \times 8) + (1 \times 6) = 43\text{l/s}$

# Standards and other references

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## Standards referred to:

I.S. EN 13141-1:2004 Ventilation for buildings. Performance testing of components/products for residential ventilation. Externally and internally mounted air transfer devices

I.S. EN 13141-4:2004 Ventilation for buildings. Performance testing of components/products for residential ventilation. Fans used in residential ventilation systems

I.S. EN 13141-5:2004 Ventilation for buildings. Performance testing of components/products for residential ventilation. Part 5: Cowls and roof outlet terminal devices

I.S. EN 13141-7:2004 Ventilation for buildings. Performance testing of components/products for residential ventilation. Performance testing of a mechanical supply and exhaust ventilation units (including heat recovery) for mechanical ventilation systems intended for single family dwellings

I.S. EN 13829:2000 "Thermal performance of buildings: determination of air permeability of buildings: fan pressurization method".

BS 5250: 2002 Code of practice for control of condensation in buildings

BS 5925: 1991 Code of practice for ventilation principles and designing for natural ventilation

BS 8233 Sound insulation and noise reduction for buildings Code of Practice.

CIBSE Technical Memorandum 13 Minimising the risk of legionnaires disease

CIBSE Ventilation Hygiene Toolkit

## Other references referred to:

Building Research Establishment, IP 21/92 "Spillage of flue gases from open-flued combustion appliances"

Building Research Establishment, IP 7/94 "Spillage of flue gases from solid-fuel combustion appliances"

Building Research Establishment, IP 13/94 "Passive stack ventilation systems: design and installation"

BRE Digest 398 Continuous mechanical ventilation in dwellings: design installation and operation.

Building Research Establishment, BR 262 "Thermal Insulation - avoiding risks"

CIBSE Guide A Environmental Design

CIBSE Guide B Heating, Ventilating Air Conditioning and Refrigeration

CIBSE Application Manual 10 Natural Ventilation in non-domestic buildings

CIBSE Application Manual 13 Mixed Mode Ventilation

DEHLG, Planning Guidelines No. 9 Architectural Heritage Protection – Guidelines for Planning Authorities

Safety, Health and Welfare at Work (General Application) Regulations 2007

World Health Organisation (WHO) publication *House dust mites*, Crowther D and Wilkinson T (2008), which is included in *Public health significance of urban pests*, Bonnefoy X, Kampen H and Sweeney K, WHO Regional Office for Europe, available at [www.euro.who.int/document/e91435.pdf](http://www.euro.who.int/document/e91435.pdf)

## Other Useful Standards and Publications

I.S. EN 13141-6:2004 Ventilation for buildings. Performance testing of components/products for residential ventilation. Exhaust ventilation system packages used in a single dwelling

Sustainable Energy Ireland, DEAP Manual