



The Scottish
Government

BUILDING STANDARDS DIVISION

DOMESTIC VENTILATION

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1 PURPOSE OF THIS DOCUMENT

1.1 The building standards system in Scotland is intended to ensure that building work on both new and existing buildings is compliant with the mandatory functional standards. Compliance with the standards can be met by following the guidance set out within the Scottish Building Standards Technical Handbooks. The system also has the flexibility of allowing compliance to be achieved by solutions alternative to the technical handbook guidance. The purpose of this document is to complement existing guidance by providing supplementary information on ventilation for dwellings.

1.2 The information provided in this document describes some of the ventilation systems that may be used to ventilate new and existing dwellings and outlines the performance requirements and practical installation guidance to assist in delivering an efficient system of ventilation. It also highlights key installation issues that can affect the performance of the systems.

1.3 A key purpose of this document is to raise the awareness and requirements for the commissioning of installed ventilation systems prior to operation. The mandatory building standards for energy require mechanical ventilation systems to be commissioned to achieve optimum energy efficiency. In addition commissioning of the system is also recommended for compliance with ventilation standards.

1.4 The information provided within this document only addresses matters relating to the air quality inside the dwelling. It is acknowledged that ventilation may fulfil other roles within a dwelling such as the permanent air provision for combustion appliances. Additionally the components of the ventilation system if not installed correctly, may have a detrimental affect on the ability for elements within the dwelling to satisfy other building standards. An example of this would be incorrectly positioned fire dampers in a wall or floor that requires to be fire resisting. In these instances the relevant sections of the Technical Handbooks should be consulted. Technical Handbooks can be viewed [here](#).

1.5 The use of this document does not remove the need to obtain a building warrant where it is required by the building regulations. Furthermore, it is quite acceptable to use alternative methods to meet the functional standards of the regulations.

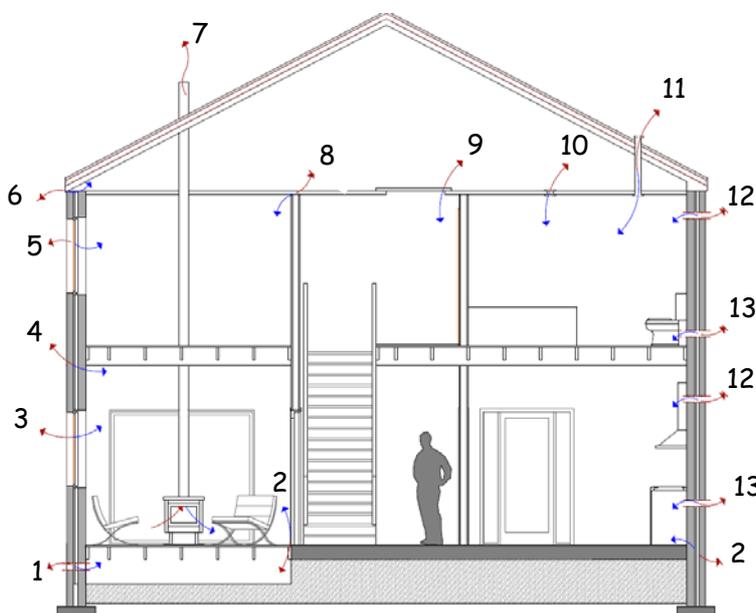
2 VENTILATION

2.1 All buildings require to be ventilated so that the air quality within the building is not a threat to the health of the occupants and this is achieved by the process of changing air in an enclosed space. A proportion of the air in the space should be regularly withdrawn and replaced with external air. To date dwellings have been generally ventilated through a combination of both “purpose provided ventilation” and “fortuitous infiltration”.

2.2 Purpose provided ventilation is the controllable air exchange between the inside and outside of a dwelling by means of a range of natural ventilating devices including windows and trickle (background) ventilators or mechanical devices such as extract and supply fans.

2.3 Fortuitous infiltration is the uncontrollable air exchange between the inside and outside of a dwelling due to pressure differences caused by wind and temperature variations. The air movement may occur through a wide range of air leakage paths through imperfections in the building structure such as cracks and gaps between building elements.

Infiltration Paths



- 1 - under floor ventilators
- 2 - floor to wall junctions
- 3 - through gaps in windows/doors
- 4 - through floor voids into the wall cavity
- 5 - around window and door frames
- 6 - ceiling to wall junctions
- 7 - open flues
- 8 - around services within hollow walls
- 9 - around the loft hatch
- 10 - service penetrations through ceiling
- 11 - vents penetrating the ceiling and roof
- 12 - around and through extract fans
- 13 - around waste pipes

2.4 Reducing the amount of fortuitous infiltration that occurs within a dwelling can play a significant part in reducing carbon emissions by minimising both the amount of warm air leaking from the dwelling and the amount of cold air entering into the dwelling. This air movement has traditionally contributed to the ventilation strategy of dwellings. However, by reducing the infiltration rate of a dwelling, for example below $5 \text{ m}^3/\text{h}/\text{m}^2$ @

50 Pa, it may necessitate the adoption of an alternative ventilation strategy to achieve satisfactory ventilation of the dwelling. This will place a greater reliance on “purpose provided ventilation” to deliver satisfactory air quality within a dwelling.

2.5 In order to be satisfied that the dwelling has an infiltration rate that satisfies the energy section of the technical standards whilst not adversely affecting the method of ventilating the dwelling it is recommended within the building regulations that sample air tightness testing be carried out. The results from the test will indicate if the dwelling has been constructed as designed. Further information on the requirements for air tightness testing can be found within clause 6.2.5 of the domestic Technical Handbook.

3 PURPOSE PROVIDED VENTILATION

3.1 Natural Ventilation

Two natural air movement forces, wind pressure and the stack effect, support the maintenance of air quality for the occupants of a dwelling. The effectiveness of both of these mechanisms in ventilating a dwelling is variable due to the air movement being influenced by the climatic conditions that occur throughout the year. Additionally, as no filtering occurs in natural ventilation, the indoor air quality can only ever be as good as the air outside.

The building components that facilitate natural ventilation can include:

- Windows, doors and rooflights
- Trickle ventilators
- Passive stack ventilator

3.2 Mechanical ventilation

A mechanical ventilation system normally relies on air movement generated by a powered fan. The effectiveness of a mechanical ventilation system relies on the design, appropriate product or component selection, installation workmanship, commissioning, maintenance and the awareness of the correct operation of the system by the occupier of the dwelling. In systems where air is mechanically introduced into the building treatment by filters may improve the quality of the indoor air.

Mechanical ventilation systems commonly include:

- Mechanical extract with natural supply (e.g. bathroom fan with trickle ventilator)
- Balanced mechanical supply and extract (e.g. Mechanical ventilation with heat recovery (MVHR))

3.3 Combined Natural and Mechanical Ventilation

There may be instances where the ventilation strategy chosen for a dwelling will incorporate elements of both natural and mechanical systems (mixed mode) to satisfy the building standards. For example, a dwelling designed where the apartments are ventilated by natural means and the moisture producing areas, such as a shower room, will be mechanically ventilated.

4 NATURAL VENTILATION – windows, doors and trickle

4.1 Natural ventilation of the dwelling may be achieved by the operation of ventilators such as trickle vents, windows, rooflights or doors. The trickle ventilators provide background ventilation and also replacement air for some mixed mode mechanical extract systems and passive stack ventilation systems. Windows, rooflights and external doors provide a rapid means of ventilating the dwelling.

4.2 To avoid noxious or dangerous gasses from entering the dwelling the ventilator should be located remote from any flue or drainage vent pipe. Refer to Section 3, Environment, of the Technical Handbooks for guidance.

4.3 Ventilators should be provided within the dwelling with an opening area of at least that shown in the table below. (The opening area should be measured as the actual geometric opening size of the ventilator).

	Window or External Door	Trickle Ventilation Provision
Apartment	1/30 th of the floor area	12,000 mm ²
Kitchen	Refer to clause 6.2	10,000 mm ²
Utility Room	Refer to clause 6.2	10,000 mm ²
Bathroom or Shower room (with or without a WC)	Refer to clause 6.2	10,000 mm ²
Toilet	1/30 th of the floor area	10,000 mm ²

Note: The overall provision of trickle ventilation in a dwelling may be provided at an average of 11,000 mm² per room with a minimum of 11,000 mm² for each apartment.

4.4 A reduced trickle ventilator provision is acceptable in existing dwellings where infiltration rates exceed 10 m³/h/m². Provision within apartments may reduce to 8000 mm² and 4000 mm² for all other rooms.

4.5 To reduce the effect of stratification and to promote air movement trickle ventilators and some part of an opening window or door should be positioned at least 1.75 m above the floor level of the room.

4.6 Where trickle ventilators are ducted, i.e. where serving an internal bathroom, the opening area of the vent stated in the table above should be doubled to compensate for the reduced air flow caused by the friction of the duct. Duct routes should be kept as straight and short as possible.

4.7 Where trickle ventilators are provided for replacement air for mechanical extract fans they should be located in a position that prevents short-circuiting of the air i.e. to avoid the replacement air being extracted before it has mixed with or displaced stale air.

4.8 Where a trickle ventilator is incorporated in an external wall a proprietary wind cowl may be necessary to reduce wind noise and over provision of ventilation.

4.9 Trickle ventilators serving bath or shower rooms may open into an area that does not generate moisture provided that area is served by a trickle ventilator in accordance with the guidance in this document.

5 NATURAL VENTILATION – passive stack ventilators

5.1 Passive stack ventilators use ducts from terminals in the ceiling of rooms to terminals on the roof that extract air to outside by a combination of the natural stack effect and the pressure effects of wind passing over the roof of the dwelling.

5.2 A passive stack ventilator may provide ventilation to a bathroom, shower room, kitchen, utility room or to a designated area within the dwelling for the drying of washing. They are suitable for use in domestic buildings up to 4 storeys in height (about 8 m maximum length of stack).

5.3 If a dwelling is to be sited near a significantly taller building (i.e. more than 50% taller) it should be positioned at least five times the difference in height away from the taller building. For example if the difference in height is 10 m the dwelling should not be sited within 50 m of the taller building.

5.4 Each space to be ventilated should be served by separate ducts and be terminated individually. This reduces the risk of air from one room being routed to another.

5.5 The circular ducts of the passive stack should be sized as follows:

Location	Diameter
Kitchen	125 mm
Utility room	100 mm
Bath / Shower room	100 mm
WC	80 mm

Note: Non-circular ducts of equivalent cross sectional area and flow resistance may be used.

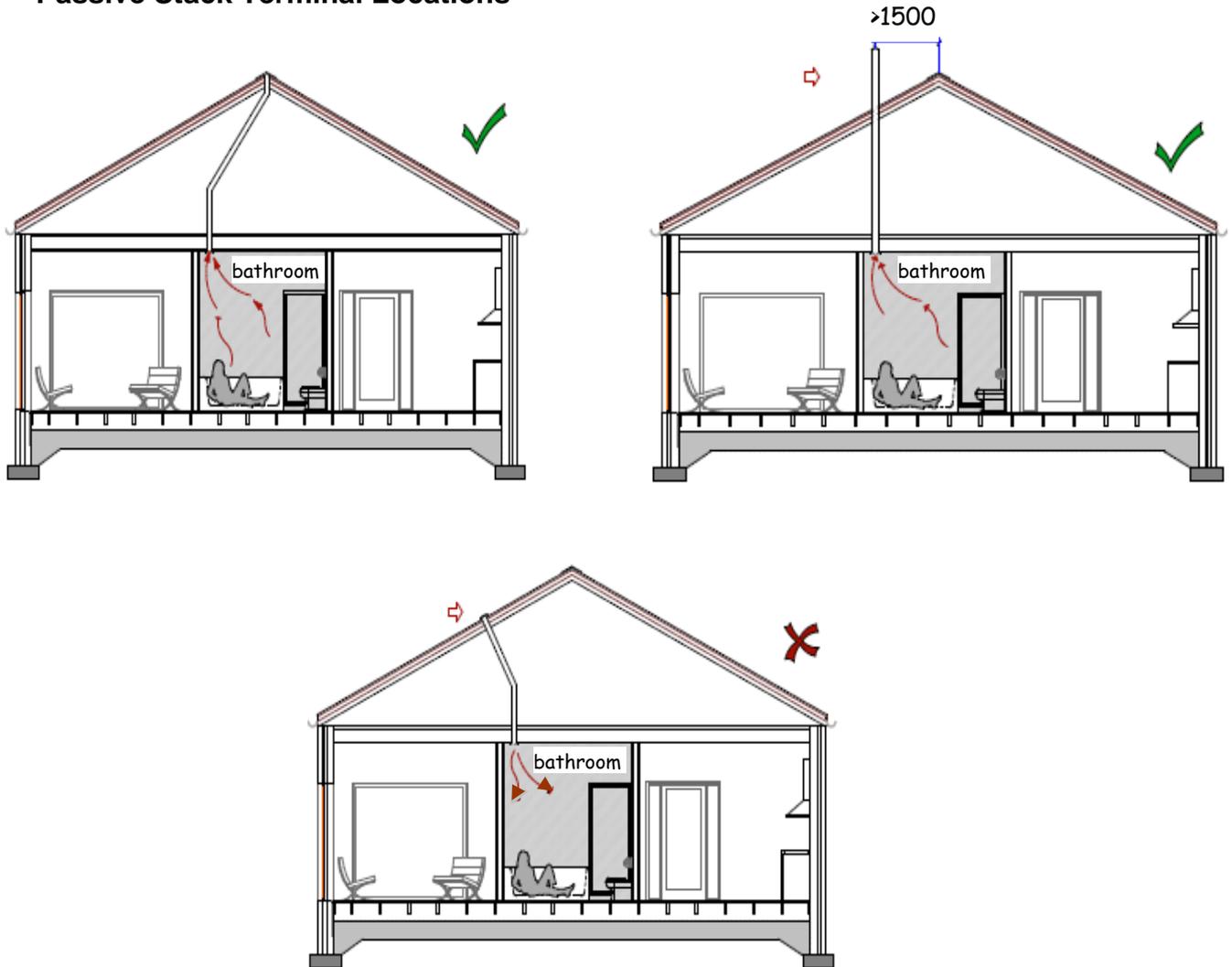
5.6 The outlet terminal of the stack should:

- have a free area of not less than the cross sectional area of the duct;
- be designed to inhibit rain from entering the duct;
- not allow the ingress of large insects or birds, (however fine fly-proof mesh should not be fitted);
- incorporate a condensation trap to allow run off of any condensation to the roof; and
- be connected to the duct in a manner that does not restrict the cross sectional area of the duct. If a conversion fitting is required to connect the duct to the terminal then the duct cross sectional area must be maintained or exceeded throughout the conversion fitting so as not to restrict the flow.

5.7 To reduce the adverse effects of wind gusts and certain wind directions the stack should terminate at:

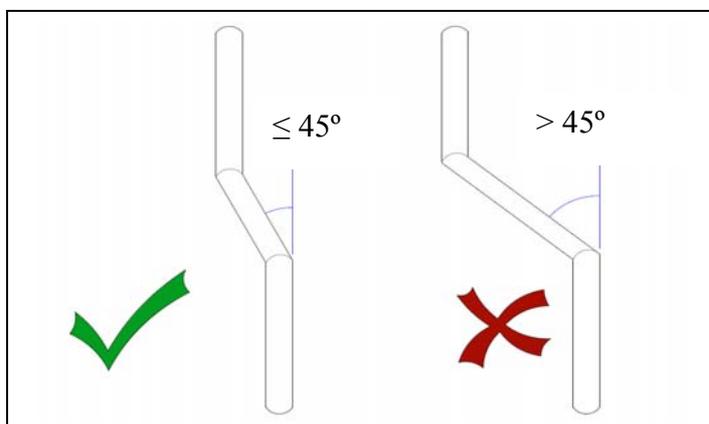
- the ridge of the roof, (being the preferred position); or
- within 1.5 m of the ridge with the duct penetrating through the roof and terminating at least level with the ridge.

Passive Stack Terminal Locations



5.8 To minimise the resistance to air flow ducts should consist of not more than one offset (i.e. not more than two bends) and these should be swept rather than sharp. Offsets should be not more than 45 degrees to the vertical.

Bends on passive stacks



5.9 Both flexible and rigid ducts have similar resistance to air flow at the rates found in passive stack systems and therefore either type may be used.

- 5.10 Flexible ducting should be:
- a. fully extended but not taut;
 - b. secured to both the extract grill and exhaust terminal;
 - c. installed in a manner such that where bends occur they are smooth, supported and do not restrict air flow;
 - d. terminated with rigid duct where it extends through the roof. The rigid pipe should project into the roof space sufficient to ensure the stability of the external duct. The connection between the flexible and rigid duct should be secure;
 - e. be fully supported throughout its length to avoid sagging, distortion and kinks; and
 - f. sealed at the junction where the duct penetrates a ceiling or floor. Where a vapour control layer is breached by a duct the continuity of the barrier should be maintained.

- 5.11 Rigid ducting should be:
- a. secured to both the extract grill and exhaust terminal;
 - b. sealed at the junction where the duct penetrates a ceiling or floor. Where a vapour control layer is breached by a duct the continuity of the barrier should be maintained; and
 - c. fully supported throughout its length.

5.12 Where the duct passes through a roof space, another unheated space, or through the roof to the external air, the duct should be insulated with at least 25 mm thick insulation having a thermal conductivity of 0.04 W/mK. This prevents the cooling of the duct thus maintaining the stack effect and reducing the risk of condensation occurring within the duct.

- 5.13 Extract grilles should:
- a. have a free area not less than the cross sectional area of the duct; and
 - b. be ceiling mounted and operate automatically with a humidity sensitive grill that operates when the relative humidity is between 50 & 65%.

5.14 Trickle ventilation should be provided to the room containing the passive stack in accordance with the table to clause 4.3 of this document.

5.15 Where a passive stack penetrates floors, walls, ceilings or cavity barriers that require a fire resistance refer to Section 2, Fire, of the Technical Handbooks for guidance.

5.16 Where a passive stack is installed this should not adversely affect the sound insulation of a separating wall or floor, internal wall or intermediate floor, refer to Section 5, Noise, of the Technical Handbooks for further guidance.

5.17 To ensure good air transfer throughout the dwelling the bottom of internal doors, that are not required to be fire resistant, should be clear of the floor finish by 5 to 8 mm.

6 MECHANICAL EXTRACT – intermittent extract fans

6.1 An intermittent extract fan is a mechanical ventilator that does not run continuously, usually only running when there is a particular need to remove pollutants or water vapour (e.g. during cooking or bathing). Intermittent operation may be under either manual control or automatic control. Humidistat control should be used for areas that are designated for the drying of washing.

6.2 The correct type of extract fan should be selected to suit the location and performance criteria of the fan. The table below identifies the extract rates that the fan should meet.

	Extract rates
Kitchen	30 l/s (108 m ³ /hr) if located above the hob 60 l/s (216 m ³ /hr) if located elsewhere
Utility room	30 l/s (108 m ³ /hr)
Bathroom or Shower room (with or without a WC)	15 l/s (54 m ³ /hr)
Toilet	3 air changes/hour
Designated Drying Area	15 l/s (54 m ³ /hr)

Note: The equivalent rates in m³/hr are provided within brackets as extract fans are commonly specified in this manner.

6.3 The product manufacturer's instructions should be followed.

6.4 Consideration should be given to the planning and installation of the ductwork in co-ordination with other trade activities and installations, such that routes are designed without compromise to the required ventilation air flow rates.

6.5 Where the fan is installed through a wall:

- the cored hole (and duct) should have a slight downward angle towards the outside to promote condensate drainage and avoid the risk of water ingress;
- the duct sleeve that connects the fan outlet to the terminal should be at least the diameter of the fan outlet; and
- the duct sleeve should be rigid and be sealed to the external and internal wall leaves to maintain air tightness. Flexible ducting may be used where rigid ducting is not possible providing ventilation rates are not compromised.

6.6 Where a fan is installed through a window the window and glass should be assessed for its suitability to incorporate the fan unit. A mounting kit from the manufacturer of the fan unit should be used.

6.7 Proprietary external discharge terminals should be used with a free area of at least 90% of the ducting being used. The terminals should prevent rain, birds and large insects from entering the system, (however fine fly-proof mesh should not be fitted).

6.8 To avoid noxious or dangerous gasses from entering the dwelling the external discharge terminal should be located remote from any flue or drainage ventilation pipe. Refer to Section 3, Environment, of the Technical Handbooks for guidance.

6.9 Trickle ventilators should be provided in an area fitted with mechanical extraction in accordance with clause 4.3 of this document. These provide replacement air for the extract fan and should therefore be independent of the extract fan.

6.10 Mechanical extract fans should not adversely affect the safe operation of an open-flued appliance i.e. cause the spillage of combustion products from the appliance. Refer to Section 3 of the Technical Handbooks for guidance.

6.11 A local manual override control should be provided for an extract fan operated by automatic control.

6.12 Manual switching controls for the fans should be accessible and positioned at least 350 mm from an internal corner and between 900 – 1100 mm above floor level.

6.13 To limit the energy demand from the use of a mechanical extract fan the specific fan power should be no greater than 0.5 W/l/s.

6.14 In situations where external noise is likely to be a nuisance to the occupants a sound attenuator, a straight length of highly perforated pipe wrapped in mineral wool, may be fitted to the duct where it passes through the roof space.

6.15 Where a mechanical ventilation system gathers extracts into a common duct for discharge to an outlet, no connections to the system should be made between any exhaust fan and the outlet. The use of non-return valves is not recommended.

6.16 Commissioning

The following points should be observed and recorded:

- a. system installation complies with the installation clauses given above (6.1 to 6.17);
- b. the correct number of extract points and terminals been installed; and
- c. all equipment is in good condition with no obvious defects that will be hazardous or affect the system performance.

Functional Checks:

- a. temporary protection and packaging should be removed from all products;
- b. check fan operates correctly when activated by manual control (e.g. light switch), or automatic control (e.g. humidistat); and
- c. check that the fan switches off after controls are de-activated and in the case of run-on timers, that these continue to operate for the period set by the designer.

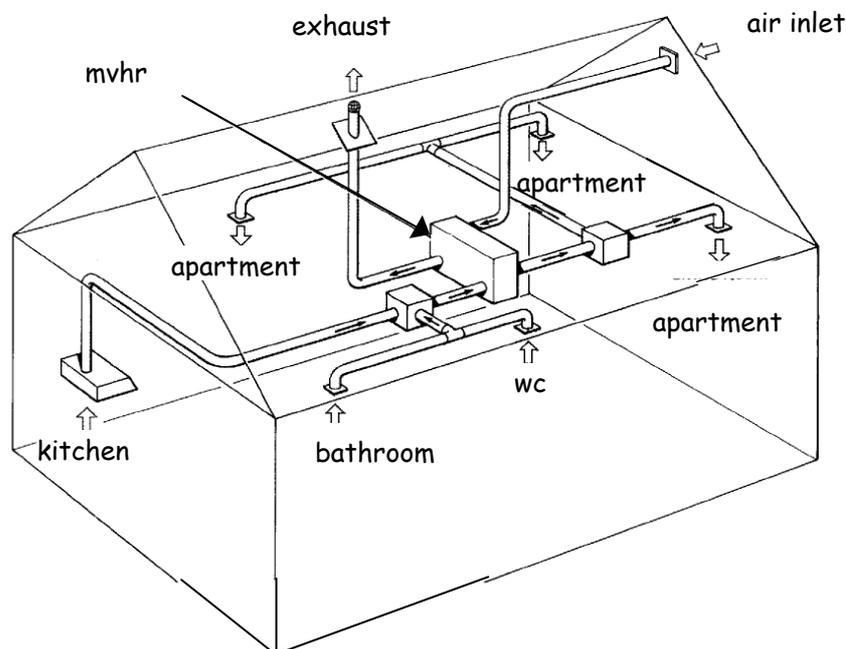
Airflow Measurements:

- a. all intended trickle ventilators or other air transfer devices should be open;
- b. all internal and external doors and windows should be closed, including the room in which measurement is being carried out;
- c. airflow measurements should be performed using a calibrated airflow device with proprietary hood attachment and results recorded in litres per second (l/s). This is commonly a vane anemometer or similar device that should be calibrated annually and be capable of achieving an accuracy of $\pm 5\%$. Reference should be made to design airflow rates; and
- d. record the extract airflow for each extract fan onto the commissioning sheet.

7 MECHANICAL VENTILATION – continuously operating balanced supply and extract ventilation (with or without heat)

7.1 A continuously operating balanced supply and extract ventilation system consists of centrally ducted supply and extract fans that operate continuously. The extract ducts serve the moisture producing areas of the dwelling with the supply ducts serving the habitable rooms. Free movement of air between these areas and rooms is therefore essential. Where fitted, heat recovery systems operate by way of the warm extracted air being passed through a heat exchanger prior to being exhausted. This recovered heat is then used to preheat the supply air to the habitable rooms.

Balanced supply and extract system



7.2 The total extract air flow rate during normal operation should be equivalent to at least 0.5 air changes per hour based on the volume of the whole dwelling. A facility to boost the air extract rate should be provided.

7.3 Opening windows should be provided where possible to assist in cooling the dwelling in hot weather.

7.4 To ensure good air transfer throughout the dwelling the bottom of internal doors, that are not required to be fire resistant, should be clear of the floor finish by 5 to 8 mm.

7.5 The product manufacturer's instructions should be followed.

7.6 The fan unit should be:

- located as specified by the system designer. The location of the fan unit should minimise overall duct run length, both from the internal terminals to the fan unit and from the fan unit to the external discharge terminal;
- located to allow safe access to undertake routine maintenance to the unit;

- c. installed to allow sufficient space for replacement at the end of its operational life of both the whole unit or of key mechanical/electrical components. This should be achievable without the need to remove fixed structures or remove significant lengths of connected ductwork;
- d. installed on a suitable sound structure, which is stable and level;
- e. insulated to minimise the potential of condensation forming within, or on, the fan unit casing. This is not necessary if the unit is pre-insulated;
- f. provided with a condensate drain that terminates in an appropriate location. The condensate pipe should be installed to have a minimum 5° fall from the fan unit. The drain should be adequately secured and where passing through an unheated space must be insulated to prevent freezing. (The rate of condensate forming may be up to several litres per day and therefore the location of the drain should take account of this); and
- g. installed using the manufacturer's supplied or recommended fixing brackets. Anti-vibration isolation may be necessary for the extract unit and should be installed in accordance with the manufacturer's instructions.

7.7 Room Supply and Extract Terminals:

- a. air extract terminals should be installed as detailed by the system designer;
- b. air extract terminals should be installed as close to ceiling level as practical;
- c. air supply terminals must not be located adjacent to walls, unless designed to discharge air away from the wall. This reduces the production of down draughts;
- d. in open plan areas where both supply and extract terminals may be installed, for example kitchen diners, consideration should be given to the proximity of the terminals to avoid short circuiting of the air i.e. to avoid the replacement air being extracted before it has mixed with or displaced stale air; and
- e. the number and location of terminals installed in a ventilated space should allow effective air distribution and minimise air noise when the system is operating at boosted air flow rates.

Fixed Terminals:

If the supply and extract air terminals are fixed, ensure that effective balancing of the system can be achieved. If this is not provided within the fan unit then dampers should be installed within the duct system to allow balancing when the system is commissioned.

Adjustable Terminals:

Ensure each terminal/grille can be locked in its commissioned position once system balance has been achieved. It is vital for the correct operation of the system that the system remains balanced in its commissioned state.

7.8 External Supply and Discharge Terminals – roof and wall mounted:

- a. proprietary terminals should be used. The terminals should prevent rain, birds and large insects from entering the system, (however fine fly-proof mesh should not be fitted);
- b. the free area of the terminal opening should be a minimum of 90% of the free area of the ducting being used;
- c. the location of the external discharge terminal should be positioned to minimise the potential for recirculation of extract air through the supply air terminal. It is recommended that the supply and extract air terminals are separated by a distance of 2 metres;

- d. to avoid noxious or dangerous gasses from entering the dwelling the external discharge terminal should be located remote from any flue or drainage vent pipe. Refer to Section 3, Environment, of the Technical Handbooks for guidance; and
- e. a cored hole (and duct) through the external wall should have a slight downward angle towards the outside to promote condensate drainage and avoid the risk of water ingress.

7.9 Controls:

- a. continuous ventilation systems should not allow the occupier to turn off the fan other than at the local isolator. Provision of an on/off function may result in the fans being operated intermittently and the required continuous air flow ventilation rates not being achieved;
- b. where sensors are not pre-installed within the fan unit or additional optional sensors can be installed, only the sensors specified by the manufacturer of the fan unit should be installed;
- c. if sensors are duct mounted, their location should be noted and provisions for access for maintenance or replacement made;
- d. if control of the fan speed is undertaken manually, the method of operating the fan in boost mode should be made obvious. This will minimise the likelihood of it being left on unnecessarily. Switching should be provided locally to the spaces being served e.g. bathrooms, kitchen; and
- e. Manual switching controls for the fans should be accessible and positioned at least 350 mm from an internal corner and between 900 – 1100 mm above floor level.

7.10 To limit the energy demand from the use of a mechanical extract system the specific fan power of the extract unit should be no greater than 1.5 W/l/s.

7.11 The heat recovery efficiency of a mechanical ventilation and heat recovery system should be 70% or more.

7.12 Where a duct breaches a vapour control layer the continuity of the layer should be reinstated.

7.13 Commissioning:

Visual Inspection:

The following points should be observed and recorded:

- a. the system complies with the installation clauses given above (7.1 to 7.12);
- b. the system is installed in accordance with design criteria;
- c. all ductwork and terminals are in good condition with no obvious defects that will be hazardous or affect the system performance;
- d. on the initial start up check that air flow direction is correct at each room terminal, supply and extract; and
- e. check for any abnormal noises on start-up or when the system is running in normal background ventilation mode (some units have a start up diagnostic sequence that runs the fans at maximum speed before reverting to normal operation – refer to the manufacturer's instructions).

Air Flow Balancing:

The system should be balanced to ensure that design air flow rates are achieved at each room. As there are several methods of control that may be used in domestic systems the fan manufacturer's instructions should be followed to achieve balancing. If specific details are not included the following steps should be adopted:

- a. Adjustable terminals and a fixed (stepped) speed fan:
 - the fan speed should be set to achieve the desired continuous flow rate;
 - the index terminal flow rate is set to full open and all other terminals are adjusted to achieve the required flows at each terminal. (The index terminal can be assumed to be the furthest from the fan unit);
 - if the total flow rate cannot be achieved through all the terminals then the fan speed should be increased; and
 - if all the terminals have to be closed significantly to achieve only the required air flow rate then reduce the fan speed and rebalance the terminals.
- b. Adjustable terminals and controllable speed fan:
 - the fan speed should be set approximately to achieve the desired continuous flow rate;
 - the index terminal flow rate should be set with the terminal fully open and all other terminals are adjusted to achieve the required flows at each terminal; and
 - if the index terminal has to be closed to achieve only the required air flow rate, then reduce the fan speed and rebalance the terminals.
- c. Fixed terminals with flow adjustment by duct damper or similar device at the fan unit:
 - as a. or b. above depending on the type of fan speed control.
- d. Adjustable terminals and fixed volume flow fan:
 - the fan speed should be set to achieve the desired continuous flow rate;
 - the index terminal flow rate should be set with the terminal fully open and all other terminals are adjusted to achieve the required flow rate; and
 - adjustment of the terminals achieves balancing only; total flow rate is governed by the fan control setting. Great care should be taken not to close the terminals too far as the fan unit will always maintain a constant volumetric flow rate; closing the terminals will only require the fan to work harder to achieve a given air flow rate.
- e. Fixed terminals with automatic flow adjustment at the fan unit:
 - the fan speed should be set to achieve the desired continuous flow rate; and
 - the flows are balanced by automatic devices located within the fan unit and therefore no adjustment can be made.

Airflow Measurements:

- a. all internal and external doors and windows should be closed, including rooms in which measurements are being carried out;
- b. air flow measurements should be performed using a calibrated airflow device with proprietary hood attachment and the results recorded in litres/second (l/s). This is commonly a vane anemometer or similar device that should be calibrated annually and be capable of achieving an accuracy of $\pm 5\%$. Reference should be made to design airflow rates; and

- c. record the airflow rate at each room terminal onto the commissioning sheet, along with the design air flow rate for each terminal. Measurements should be taken at both maximum rate and minimum rate fan speeds.

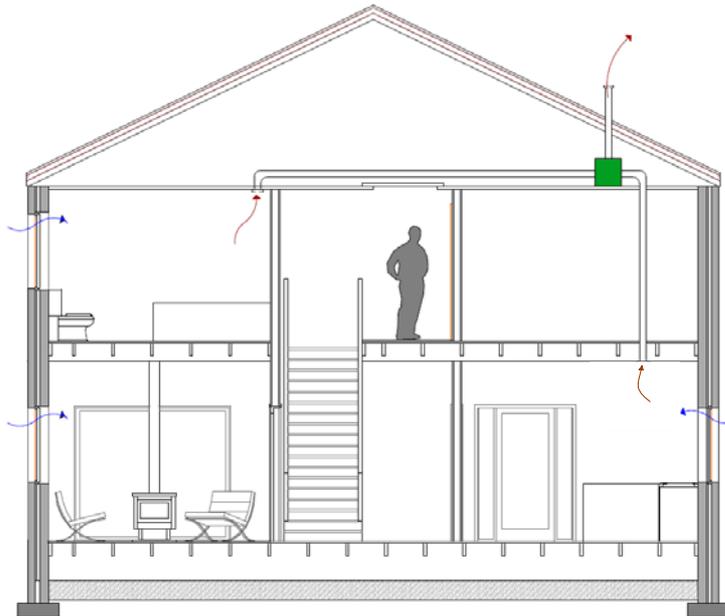
Controls:

- a. all local controls should be installed following the manufacturer's instructions;
- b. all local controls should be labelled, indicating their function;
- c. if sensors have been installed separately from the fan unit ensure installation follows the manufacturer's instructions;
- d. where control of the fan is automated, the controls should be configured to minimise the occurrence of hunting. Hunting is where the fan speed continually increases and decreases. If this does occur the occupants may seek to modify the control system or turn it off to remove the noise nuisance;
- e. where manual controls are provided clear and detailed instructions should be made available to the occupier; and
- f. as far as practical the correct operation of each control function should be tested.

8 MECHANICAL VENTILATION – continuously operating extract

8.1 A continuously operating extract ventilation system generally consists of a centrally ducted extract fan that serves the moisture producing areas within the dwelling. Replacement air is provided throughout the dwelling by infiltration and trickle ventilator provision.

Continuously Operating Extract System



8.2 The total extract air flow rate during normal operation should be equivalent to at least 0.5 air changes per hour based on the volume of the whole dwelling. A facility to boost the air extract rate should be provided.

8.3 Trickle ventilators should be installed in accordance with clause 4.3 of this document. Opening windows should be provided to assist in cooling the dwelling in hot weather.

8.4 To ensure good air transfer throughout the dwelling the bottom of internal doors, that are not required to be fire resistant, should be clear of the floor finish by 5 to 8 mm.

8.5 The location of the fan unit should minimise overall duct run length, both from the internal terminals to the fan unit and from the fan unit to the external discharge terminal.

8.6 The product manufacturer's instructions should be followed.

8.7 The fan unit should be:

- a. located as specified by the system designer;
- b. installed to allow sufficient space to undertake routine maintenance;
- c. installed to allow sufficient space for replacement at the end of its operational life of both the whole unit or of key mechanical/electrical components. This should

be achievable without the need to remove fixed structures or remove significant lengths of connected ductwork;

- d. installed on a suitable sound structure, which is stable and level;
- e. insulated to minimise the potential of condensation forming within or on the fan unit casing. This is not necessary if the unit is pre-insulated; and
- f. installed using the manufacturer's supplied or recommended fixing brackets. Anti-vibration isolation may be necessary for the extract unit and should be installed in accordance with the manufacturer's instructions.

8.8 Room Extract Terminals:

- a. room air extract terminals should be installed as detailed by the system designer;
- b. room air extract terminals should be installed as close to ceiling level as practical;
- c. where the extract terminals are fixed, there should be a means of achieving effective balancing of the system. If this is not provided within the fan unit then dampers should be installed within the duct system to allow balancing when the system is commissioned; and
- d. if the terminals are adjustable each terminal should be capable of being locked in its commissioned position once system balance has been achieved. It is vital for the correct operation of the system that the system remains balanced in its commissioned state.

8.9 External Discharge Terminals – roof and wall mounted:

- a. proprietary terminals should be used;
- b. the free area of the terminal opening should be a minimum of 90% of the free area of the ducting being used. The terminals should prevent rain, birds and large insects from entering the system, (however fine fly-proof mesh should not be fitted);
- c. the location of the external discharge terminal should minimise the potential for recirculation of extract air through ventilation air inlets;
- d. a cored hole (and duct) through the external wall should have a slight downward angle towards the outside to promote condensate drainage and avoid the risk of water ingress; and
- e. to avoid noxious or dangerous gasses from entering the dwelling the external discharge terminal should be located remote from any flue or drainage vent pipe. Refer to Section 3, Environment, of the Technical Handbooks for guidance.

8.10 Controls:

- a. continuous ventilation systems should not allow the occupier to turn off the fan other than at the local isolator. Provision of an on/off function will result in the fans being operated intermittently and the required continuous air flow ventilation rates not being achieved;
- b. where sensors are not pre-installed within the fan unit, or additional optional sensors can be installed, only the sensors specified by the manufacturer of the fan unit should be installed;
- c. if sensors are duct mounted, their location should be noted and provisions for access for maintenance or replacement made;
- d. if control of the fan speed is undertaken manually, the method of operating the fan in boost mode should be made obvious. Switching should be provided locally to the spaces being served e.g. bathrooms, kitchen; and

- e. Manual switching controls for the fans should be accessible and positioned at least 350 mm from an internal corner and between 900 – 1100 mm above floor level.

8.11 To limit the energy demand from the use of a mechanical extract system the specific fan power of the extract unit should be no greater than 0.7 W/l/s.

8.12 Where a duct breaches a vapour control layer the continuity of the layer should be reinstated.

8.13 Mechanical extract fans should not adversely affect the safe operation of an open-flued appliance i.e. cause the spillage of combustion products from the appliance. Refer to Section 3 of the Technical Handbooks for guidance.

8.14 Commissioning

Visual Inspection:

The following points should be observed and recorded:

- a. the system installation complies with the installation clauses given above (8.1 to 8.13);
- b. the system is installed in accordance with design criteria;
- c. all ductwork and terminals are in good condition with no obvious defects that will be hazardous or affect the system performance;
- d. on the initial start up check that air flow direction is correct at each room terminal; and
- e. check for any abnormal noises on start-up or when the system is running in normal background ventilation mode (some units have a start up diagnostic sequence that runs the fans at maximum speed before reverting to normal operation – refer to the manufacturer's instructions).

Air Flow Balancing:

The system should be balanced to ensure that design air flow rates are achieved at each room. As there are several methods of control that may be used in domestic systems the fan manufacturer's instructions should be followed to achieve balancing. If specific details are not included the following steps should be adopted:

- a. Adjustable terminals and a fixed (stepped) speed fan:
 - the fan speed should be set to achieve the desired continuous flow rate;
 - the index terminal flow rate is set to full open and all other terminals are adjusted to achieve the required flows at each terminal (the index terminal can be assumed to be the furthest from the fan unit);
 - if the total flow rate cannot be achieved through all the terminals then the fan speed should be increased; and
 - if all the terminals have to be closed significantly to achieve only the required air flow rate then reduce the fan speed and rebalance the terminals.
- b. Adjustable terminals and controllable speed fan:
 - the fan speed should be set approximately to achieve the desired continuous flow rate;
 - the index terminal flow rate should be set with the terminal fully open and all other terminals are adjusted to achieve the required flow rate;

- if the index terminal has to be closed to achieve only the required air flow rate, then reduce the fan speed and rebalance the terminals.
- c. Fixed terminals with flow adjustment by duct damper or similar device at the fan unit:
- as a. or b. above depending on the type of fan speed control.
- d. Adjustable terminals and fixed volume flow fan:
- the fan speed should be set to achieve the desired continuous flow rate;
 - the index terminal flow rate should be set with the terminal fully open and all other terminals are adjusted to achieve the required flows at each terminal; and
 - adjustment of the terminals achieves balancing only; total flow rate is governed by the fan control setting. Great care should be taken not to close the terminals too far as the fan unit will always maintain a constant volumetric flow rate; closing the terminals will only require the fan to work harder to achieve a given air flow rate.
- e. Fixed terminals with automatic flow adjustment at the fan unit:
- the fan speed should be set to achieve the desired continuous flow rate; and
 - the flows are balanced by automatic devices located within the fan unit and therefore no adjustment can be made.

Airflow Measurements:

- a. all trickle ventilators or other air transfer devices should be open;
- b. all internal and external doors and windows are closed, including rooms in which measurements are being carried out;
- c. air flow measurements should be performed using a calibrated airflow device with proprietary hood attachment and the results recorded in litres/ second (l/s). This is commonly a vane anemometer or similar device that should be calibrated annually and be capable of achieving an accuracy of $\pm 5\%$. Reference should be made to design airflow rates; and
- d. record the airflow rate at each room terminal onto the commissioning sheet, along with the design air flow rate for each terminal. Measurements should be taken at both maximum rate and minimum rate fan speeds.

Controls:

- a. all local controls should be labelled, indicating their function clearly;
- b. all local controls should be installed following the manufacturer's instructions;
- c. if sensors have been installed separately from the fan unit ensure installation follows the manufacturer's instructions;
- d. where control of the fan is automated, the controls should be configured to minimise the occurrence of hunting. Hunting is where the fan speed continually increases and decreases. If hunting does occur the occupants may seek to modify the control system or turn it off to remove the noise nuisance;
- e. where manual controls are provided clear and detailed instructions should be made available to the occupier; and
- f. as far as practical the correct operation of each control function should be tested.

9 MECHANICAL VENTILATION - ductwork

9.1 General Recommendations:

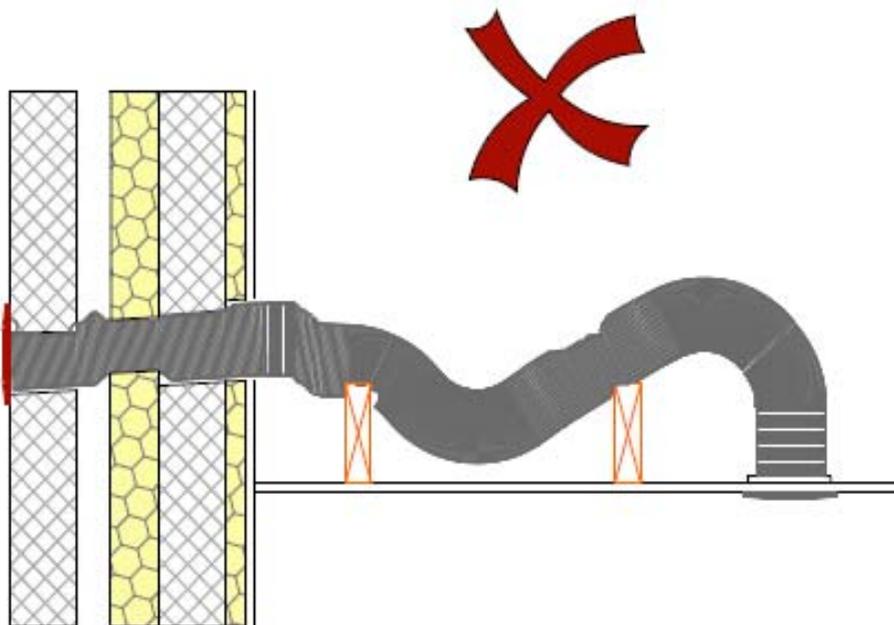
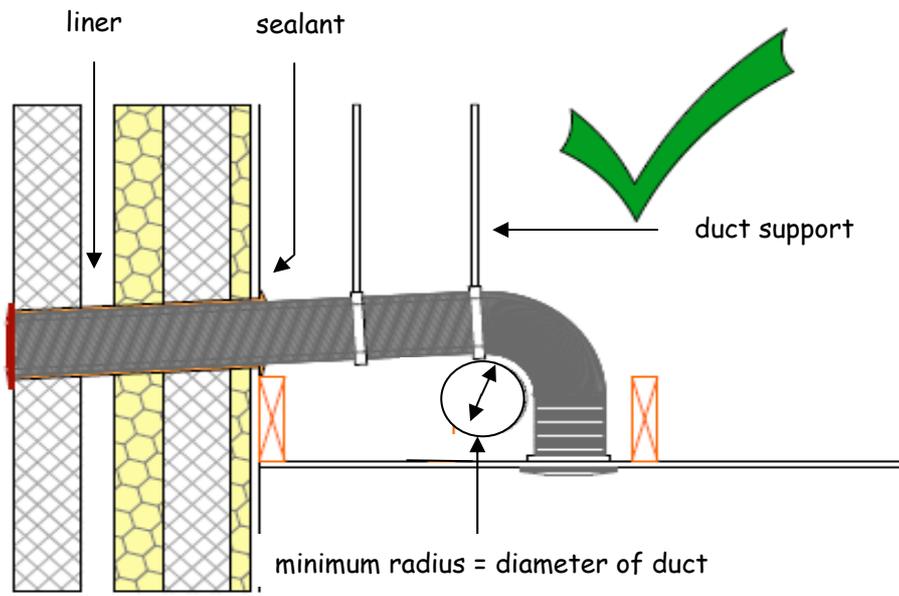
Ducting should be:

- a. installed where it cannot be easily damaged e.g. across open loft areas where it may be stood on;
- b. installed to allow sufficient space to allow access for cleaning ducts where room extract terminal are not fitted with filters;
- c. insulated where it passes through unheated areas with the equivalent of at least 25 mm of a material with a thermal conductivity not more than 0.04 W/mK. This reduces the risk of condensation occurring within the duct;
- d. insulated or be fitted with a condensate trap where the duct extends above roof level. The condensate trap should be fitted just below roof level;
- e. insulated where carrying cold air between the external supply/discharge terminals and the fan unit within the heated envelope. A vapour barrier should be wrapped outside the insulation to prevent condensation occurring within the insulation material;
- f. fitted with a condensate trap where it is installed vertically. The trap should prevent condensation from damaging the mechanical extract fan;
- g. arranged to slope slightly downwards away from the fan unit, to prevent backflow of any moisture into the unit, when installed horizontally;
- h. sized to minimise pressure loss and noise generation. This is achieved by sizing of the ducts to limit the air velocity. The main ducts should be run at the same size as the fan unit spigot; and
- i. routed in a manner which minimises overall duct length and the number of bends required. It is particularly important to minimise bends in main ducts operating at higher air velocities.

9.2 Flexible ducting:

- a. should be pulled taut to ensure that the full internal diameter is obtained and flow resistance minimised. This is considered to have been achieved if the duct is extended to 90% of its maximum length;
- b. should be supported at suitable intervals to minimise sagging. It is suggested it should be supported at no greater than 600 mm intervals;
- c. bends in ducts should have a minimum inside radius equal to the diameter of the duct. If tighter bends are required, rigid bends should be used; and
- d. perforated insulated flexi duct, used to minimise airborne sound transmission, should not be used between the fan unit and the external discharge terminal to prevent condensation occurring within the insulation material.

Flexible Ducting Installation



9.3 Duct Connections:

- a. all duct connections require to be sealed. Where ducts are installed against a solid structure this can be difficult to achieve. In such locations pre-assembly of duct sections should be considered. This will require that connections are permanent to ensure the seal is maintained during installation;
- b. where access to ducts will not be possible after construction is complete, i.e. ductwork within floor and wall voids, consideration should be given to permanent connection and sealing with an appropriate non-hardening sealant, not using duct tape to achieve connection and sealing;
- c. connection of lengths of flexible duct must use a rigid connector and jubilee clips or similar to ensure a long term seal is achieved. Connections of lengths of flexible duct should not be taped only; and
- d. connection of components should not result in significant air flow resistance. Components should be proprietary and fit easily together without distortion.

9.4 Where a duct breaches a vapour control layer the continuity of the layer should be reinstated.

9.5 Where an extract duct is installed this should not adversely affect the sound insulation of a separating wall or floor, internal wall or intermediate floor refer to Section 5, Noise, of the Technical Handbooks for guidance.

9.6 Where an extract duct penetrates cavity barriers or floors, ceilings and walls that require a fire resistance refer to Section 2, Fire, of the Technical Handbooks for guidance.

10 WRITTEN INFORMATION FOR VENTILATION SYSTEMS

10.1 Correct use and maintenance of the ventilation systems will assist in delivering the designed ventilation to the dwelling whilst minimising energy use and environmental problems such as noise and thermal discomfort. To assist in this, the following information should be provided where relevant:

- a. design statement that sets out the key characteristics of the system along with non-technical information on how and when the system should be used;
- b. manufacturer's contact details;
- c. instructions on how to use trickle ventilators for background ventilation;
- d. location of and setting of automatic controls (humidity and timer controls);
- e. location and use of on/off and boost settings for mechanical ventilation system;
- f. Instructions on how and when cleaning and maintenance should be carried out including filter replacement;
- g. location of filters if not within the fan unit;
- h. if there are no filters on extract terminals, how ducts can be accessed for cleaning and recommendations on how and when cleaning should be undertaken;
- i. instructions on how to recalibrate or check sensors and their location; and
- j. manufacturer's literature that may include information such as a spare parts list, means of obtaining spare parts, guarantees etc.

11 EXAMPLE VENTILATION SOLUTIONS

11.1 The following example solutions identify four alternative approaches to providing ventilation within a dwelling. Solutions 1 and 2 may be adopted for dwellings having an air infiltration rate between 5 and 10 m³/h/m². Solutions 3 and 4 may be adopted for dwellings with an air infiltration rate less than 5 m³/h/m².

NEW DWELLING	INFILTRATION RATE: 5 — 10 m ³ /h/m ²
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Example Ventilation Solution 1: Natural with Intermittent Mechanical Extract

	Apartment	Kitchen	Bathroom / Shower	Toilet	Utility Room
Openable Ventilator	1/30 th floor area			1/30 th floor area [2]	
Trickle Ventilator	12000 mm ²	10000 mm ²	10000 mm ²	10000 mm ²	10000 mm ²
Intermittent Mechanical Extract		60 l/sec (216 m ³ /hr) [1] [3]	15 l/sec (54 m ³ /hr)		30 l/sec (108 m ³ /hr)

Note:

- [1] May be reduced to 30 l/sec (108 m³/hr) if located above a hob.
- [2] May be substituted by mechanical extract capable of 3 air changes per hour.
- [3] Humidistat control should be used if designated drying area for washing.

Example Ventilation Solution 2: Natural

	Apartment	Kitchen	Bathroom / Shower	Toilet	Utility Room
Openable Ventilator	1/30 th floor area			1/30 th floor area [2]	
Trickle Ventilator	12000 mm ²	10000 mm ²	10000 mm ²	10000 mm ²	10000 mm ²
Passive Stack System		125 mm stack [1]	100 mm stack [1]		100 mm stack [1]

Note:

- [1] Incorporating a ceiling mounted automatic humidity sensitive extract grille.
- [2] May be substituted by mechanical extract capable of 3 air changes per hour.

Example Ventilation Solution 3: Continuously Operating Mechanical Extract

	Apartment	Kitchen	Bathroom / Shower	Toilet	Utility Room
Openable Ventilator	1/30 th floor area ^[1]			1/30 th floor area ^[1]	
Trickle Ventilator	12000 mm ²	10000 mm ²	10000 mm ²	10000 mm ²	10000 mm ²
Continuously Operating Mechanical Extract ^[2]	0.5 ACPH minimum	0.5 ACPH minimum and 25 -50% boost	0.5 ACPH minimum and 25 -50% boost	0.5 ACPH minimum	0.5 ACPH minimum

Note:

- [1] Openable ventilators (generally windows) are required for summer cooling, rapid ventilation and for use when the mechanical system is switched off.
- [2] Based on whole house ventilation rate.

Example Ventilation Solution 4: Continuously Operating Balanced Supply and Extract (with or without Heat Recovery)

	Apartment	Kitchen	Bathroom / Shower	Toilet	Utility Room
Openable Ventilator	1/30 th floor area ^[1]			1/30 th floor area ^[1]	
Trickle Ventilator					
Continuously Operating Mechanical Extract ^[2]	0.5 ACPH minimum	0.5 ACPH Minimum and 25 - 50% boost	0.5 ACPH minimum and 25 - 50% boost	0.5 ACPH minimum	0.5 ACPH minimum

Note:

- [1] Openable ventilators (generally windows) are required for summer cooling, rapid ventilation and for use when mechanical system switched off.
- [2] Based on whole house ventilation rate.