

The Scottish Building Standards Technical Handbook

Domestic



3.A.9 Carbon Dioxide Monitoring Equipment

This guidance supplements information provided under clause 3.14.7.

Air within a dwelling can contain an array of both naturally occurring and synthetic contaminants, particulates and gases. The majority of these contaminants are not easily identifiable to the occupants, even at relatively high levels. Research carried out recently for the Building Standards Division ([available here](#)) indicated that over

90% of occupiers believe the indoor air quality within their main bedrooms is very good or fairly good. However, onsite monitoring of carbon dioxide (CO₂) levels found that 83% of properties tested had time weighted concentrations greater than 1,000 parts per million (ppm) within the main bedrooms.

Although in terms of health and safety, exposure to CO₂ levels of up to 5,000 ppm over an 8 hour period is generally not considered a risk¹ (1 1 HSE Publication EH40/2005 Workplace exposure limits - 8 hour time weighted average), levels of over 1,000 ppm can be taken as an indicator of poor ventilation rates. High levels of CO₂ will, therefore, be associated with the presence of higher levels of other contaminants, such as volatile organic compounds, formaldehyde, particulates, bacteria, etc. The levels of these other contaminants are less easy to identify accurately without very sensitive testing equipment.

As dwellings become more air-tight the levels of uncontrolled “background ventilation” decreases. This results in a greater reliance on occupant interaction with controllable ventilators, such as windows and background ventilators, to maintain satisfactory levels of indoor air quality. However, as indicated above, occupants are frequently not aware of the need to ventilate. Therefore, to raise occupant awareness of poor ventilation, as evidenced by high levels of CO₂, the guidance to building standard 3.14 calls for a CO₂ monitor to be installed in the main or principal
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bedroom in a dwelling constructed to a level of airtightness lower than 15 m³/hr/m² at 50Pa. Dwellings with levels of air-tightness leakier than 15 m³/hr/m² at 50Pa will have more uncontrolled ventilation, however, current building practices should be considered, as the completed building may be inadvertently constructed tighter than designed.

The main or principal bedroom was determined to be the best location for the CO₂ detection equipment as this is likely to be the room most frequently occupied for long periods of time. In addition, it is unlikely that the ventilation of the room will change during the period of occupation. That is to say, if windows, background ventilators or doors are closed when the residents go to bed it is unlikely that they will be opened before they rise the next day. It is reasonable to assume that if there are high levels

of CO₂ indicated in the monitored bedroom, levels elsewhere in the property will also be high. The ventilation strategy adopted to reduce CO₂ should, therefore be replicated in other occupied rooms in the home.

It is not intended that the CO₂ monitoring equipment sounds an alarm if the concentration levels exceed 1,000 ppm as it is considered that this could lead to the permanent disabling of the monitor. Rather, it is intended that occupants can interrogate the equipment the next day and make informed decisions on how to ventilate their home. The Technical Handbook guidance also calls for information on the ventilation strategy and CO₂ monitoring to be provided to the householder. This information is expected to cover the operation of the specific CO₂ monitor installed (i.e. not generic guidance), an explanation of what the results the equipment is giving mean and suggested remedial action that can be taken to reduce subsequent overnight CO₂ levels.

The guidance allows the CO₂ monitoring equipment to be either a single unit with detector head and screen or separate detector and screen. In the case of a single unit this would be sited within the main or principal bedroom where the screen can be easily read. Where the detector is separate from the screen the detector should be sited in the main or principal bedroom but the monitor may be sited elsewhere, for example, in a hallway. The benefit of separate units is that additional detectors, sited in other rooms may be connected to the monitor for additional coverage.

A CO₂ monitor should be permanently fixed and is required to be mains operated. It should be capable of recording and displaying readings within a range of at least 0 – 5,000 parts per million CO₂ and logging and displaying data at no more than 15 minute intervals for at least a 24 hour period. A CO₂ monitor should be capable of measuring the actual level of carbon dioxide present in the room they are located in. Monitors that give an "equivalent" or "EQ" concentration of CO₂ are not suitable as they are not sensitive to CO₂ but are mixed gas sensors.

To allow free air movement over the detector head a CO₂ detector head should not be sited where air flow may be restricted. For example, close to corners of walls or ceiling/wall junctions, where curtains may be expected to be fitted. The average person exhales approximately 45,000 parts per million of CO₂ in every breath.

Therefore to prevent potential false readings from exhaled breath the detector head should be sited away from where the head of the bed would be expected to be located.

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When monitoring concentration levels of CO₂ within dwellings it should be remembered that CO₂ is present in outside air at concentration levels of between 350 and 575 ppm. As all the ventilation strategies within the Technical Handbooks rely on an exchange of air from outside the in-door concentration levels of CO₂ will be more or less the same as the external air in the proximity of the property.

Although most whole house ventilation systems include some form of filtration on the incoming air ducts, even they do not prevent CO₂ entering the building.

The guidance in the Domestic Technical Handbook calls for occupiers of newly constructed dwellings to be provided with guidance on the operation of CO₂ monitoring equipment and their options for improving ventilation when indicated as necessary by the monitor.

Written information to be passed to the dwelling occupant should include:

a. The purpose of the carbon dioxide monitoring equipment is to inform occupants of CO₂ levels within their dwelling over the preceding 24 hour period. This information can then be used by the occupants to determine the quality of air within their homes and whether additional ventilation is required, for example, opening or increasing the opening of background ventilators. This section should advise that CO₂ is always present in the air we breathe at levels of around 400 ppm and that levels of CO₂ of up to 5,000 ppm are generally not considered to be a risk. However, concentration levels greater than 1,000 ppm can be indicative of poor ventilation and consequently, high levels of other contaminants.

b. Specific details of the CO₂ monitoring equipment, including manufacturer's operating instructions. Instructions on operation (manufacturer's or otherwise) should include:

- The location of the CO₂ sensor(s) and monitor
- Initial set up procedure
- How to switch between available modes, where available

- How to de-activate the audible alarm, where fitted
- How to adjust the time between data logging events, this should be set at a maximum of 15 minute intervals
- How to interrogate the monitor to determine CO2 levels over the preceding 24 hour period
- Details and timeframe for re-calibrating the detector
- Advice on location of furniture near the detector head that may affect the operation of the unit, in particular the bedhead

c. Details of the ventilation strategy adopted in the dwelling, including but not limited to:

- Window operation, including where possible means of securing windows in a partially open position to prevent unauthorised entry
- Background ventilation location and operation
- Mechanical ventilation – intermittent operation
- Mechanical ventilation – continuous operation

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d. Information on how occupants should ventilate their dwellings where the CO2 monitor indicates concentration levels in excess of 1,000 ppm for periods of more than one hour. This information may be best presented in stages, for example:

- 800 – 999 ppm
- 1,000 – 1,199 ppm
- 1,200 – 1,499 ppm
- 1,500 – 1,999 ppm
- Over 2,000 ppm

Section 3.A.10 provides a template containing information that should be provided to occupiers of new dwellings. The text and layout within the template is intended only as a guide and should be taken as being indicative of the type of information to be provided. The generic information relating to the CO2 monitor and ventilation options, that is, windows, background ventilators and mechanical extract fans (location and operation) should be replaced with building specific information.