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Chapter 3

UK Guidance on IAQ - the New CIBSE Guide

Paul Appleby

INTRODUCTION

The CIBSE is to publish new guidance on environmental criteria later this year. This includes new material on Indoor Air Quality which provides a strategy for minimising indoor air quality problems in buildings and improving the effectiveness of outdoor air supply in controlling indoor pollution. This Chapter explains the reasons for this approach and the basis for the guidance given.

APPROACH

The philosophy behind the new CIBSE Guide Section A1 *Environmental Criteria for Design* is to provide recommended default values for specific design criteria whilst providing the assumptions on which they are based and procedures and data to use for adapting them to "non-standard" situations.

The approach recommended for controlling indoor air quality follows the principals behind occupational hygiene and the COSHH Regulations, i.e. source identification and control. The same approach can be used at the design stage or when carrying out ongoing air quality checks or a COSHH Assessment.

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The starting point is to identify what materials, equipment etc. emit pollutants into the air.

Where possible information should be obtained on the chemicals involved, their release rate, their toxicity, and occupational exposure limits and/or guideline values to exposure (e.g. WHO Air Quality Guidelines).

The following strategy should then be applied in order to minimise the risk of exposure and reduce the burden on ventilation:

1. eliminate the substance at source, or:
2. substitute either the source or the substance for one with a lower potential for health effects or odour, or:
3. reduce emission rates, or:
4. segregate occupants from the source, and, once all of these alternatives have been accounted for:
5. develop an appropriate ventilation strategy, and, if none of these measures can be guaranteed to control exposure below an acceptable level:
6. provide appropriate personal protection (mask, air-fed respirator etc.).

The latter option would normally only apply to industrial exposure and the requirements are set out in the Personal Protective Equipment at Work Regulations 1992.

The order given above is chronological, however some combination of factors 1 to 4 will normally be considered in order to reduce the dependence on ventilation to a minimum. Ventilation options available range from openable windows through mechanical dilution and displacement systems, local exhaust ventilation to enclosures. Again some combination of these may be applicable, with the aim of reducing the reliance on mechanical ventilation to a minimum.

SOURCE CONTROL

Although CIBSE provide default outdoor air supply rates based on those in the 1986 Guide the emphasis has been changed to identifying potential sources of indoor pollution and taking steps to eliminate or control them.

Potential pollutants are listed, including occupancy-dependant body-odours and environmental tobacco smoke, but also substances which originate from building materials, office furniture and equipment, cooking, moulds and from external sources such as motor vehicles, in-fill sites and industrial processes.

CIBSE recognises the concern internationally over the health effects of passive smoking and the difficulty in creating a comfortable environment for non-smokers where smoking is allowed. The trend in the UK is towards smoking controls in the workplace, and CIBSE strongly supports the introduction of these controls.

The Guide divides indoor pollutants broadly into two categories:

1. odour-free at concentrations which can have an identifiable health effect
2. malodorous - resulting in discomfort.

Many substances become irritants at concentrations above the odour threshold. Some result in narcosis or other short term health effects, whilst chronic illness may result from long term exposure.

The workplace atmosphere is a cocktail of, perhaps, thousands of substances, most of which will be at very low concentrations. Because of the uncertainties associated with exposure to these cocktails CIBSE recommend that all reasonable steps be taken to eliminate sources and control emissions, both in the design and specification of the building and its contents and during maintenance and cleaning processes.

SPECIFIC POLLUTANTS

The new Guide gives Guideline values for individual substances adapted from both the WHO Air Quality Guidelines, which have been recently revised, and the Air Quality Regulations 1997. These have been adopted by CIBSE for the non-industrial workplace, rather than Occupational Exposure Limits (OELs), which are not considered appropriate for non-industrial exposure. WHO Guidelines are based on different criteria to OELs, resulting in significantly lower values. The OEL for toluene, a commonly found solvent vapour in the non-industrial workplace, is 50 ppm for a time-weighted average (TWA) exposure of 8 hours, whereas the Guide recommends the 1998 WHO Guideline be adopted, which is 0.068 ppm for a 1 week exposure.

A table is provided in the Guide which quotes WHO Guideline concentrations for a range of airborne substances, including vapours, gases and particulates associated with both indoor and outdoor sources. These include some substances associated with vehicle exhausts for which Air Quality Objective Levels (AQOLs) have been set for England and Wales under the Air Quality Regulations 1997. Although these are intended for the use of Local Authorities, as a measure of compliance with their obligations under the Environment Act 1995 by the year 2005, CIBSE refers to them because they represent the quality of outdoor air from which it will be expected that building ventilation will draw, which, de-facto, should not be exceeded indoors.

It is interesting to note that all of the WHO Guideline and AQOL concentrations given are below the thresholds of odour for the substances listed, apart from that for Ozone, which can be detected at concentrations as low as 15 ppb, whilst the WHO Guideline is 60 ppb (8 hour TWA). Adoption of the WHO Guideline does not guarantee that discomfort from odour would not occur for short periods. For example Toluene can be detected at 5 ppm, whilst the WHO Guideline is 0.068 ppm, time weighted over a week. This means that brief excursions to concentrations above 5000 ppb would not push the 1 week TWA above 68 ppb provided they were compensated by a sufficient duration of concentrations below the TWA.

i.e. $\Sigma \{(C_1 - TWA) \times time\} = \Sigma \{(TWA - C_2) \times time\}$,

where C_1 and C_2 are concentrations above and below the TWA respectively.

The list includes known carcinogens, namely arsenic, benzene, man-made vitreous refractory ceramic fibres, nickel, radon and trichloroethylene, and provides estimated deaths from cancer for a given population size exposed to a given concentration averaged over a lifetime. For example for benzene, an ingredient of fuel for combustion engines, it has been estimated that 6 deaths from cancer could occur in a population of 1 million through lifetime exposure of 1 $\mu g/m^3$. The Local Authorities have been tasked to reduce the annual average ambient levels to 16 $\mu g/m^3$, although occupational exposure allows an 8 hour TWA exposure of 16,000 $\mu g/m^3$!

The Guide provides a procedure for determining the outdoor air supply rate for controlling the concentration of specific pollutants to below a desired level, where the emission rate of the pollutant is known, and taking account of the

average concentration of the pollutant in the outdoor air. The procedure can also take account of the ventilation effectiveness, which can vary depending on how the air is supplied into a room, the amount of short-circuiting and the buoyancy of the supply air. For example, cool air introduced close to the floor with extract at high level may result in pollutants being carried upwards before they mix with room air, i.e. displacement ventilation. Hence up to 40% less air could be used to achieve the same concentration in the breathing zone compared with full mixing.

GENERAL ODOURS

CIBSE refer to Fanger's work at the University of Denmark which has clearly demonstrated that the building, with its contents and services, represents a significant odour source which can greatly exceed the odour emitted from the occupants. The procedure which Fanger has developed for calculating outdoor air supply rate from the known odour sources in the building has not been adopted. It was considered that the basis for the procedure had not been sufficiently developed. The units of the olf and decipol are introduced however, where the olf is defined as "the sensory load on the air from an average sedentary adult in thermal neutrality" and the decipol is "the perceived air quality in a space with a sensory pollution load of 1 olf, ventilated by 10 litres per second of clean (odourless) air".

From Fanger's work, CIBSE recommend that building services designers and architects specify materials which minimise the "olf-load" on the building and hence reduce the burden placed on the outdoor air from sources other than the occupants. This philosophy should cover the maintainability of the building and its services, since many of the odour sources discovered by Fanger and his workers had become so because of inadequate maintenance.

PRESCRIBED OUTDOOR AIR SUPPLY RATES

The outdoor air supply rates recommended by CIBSE are those which were included in the 1986 Guide Section B2 : *Ventilation & Air Conditioning (Requirements)*. CIBSE have decided to retain separate outdoor air supply rates for rooms in which there would be no smoking of tobacco products and rooms where various degrees of smoking are expected.

For non-smoking rooms an outdoor air supply rate of 8 litres/s per person is recommended, whilst where there is "some smoking" the recommended rate remains as 16 litres/s per person, where "some" is defined as 25% of the occupants who are smokers, although not all smoking at the same time. This corresponds to a typical open-plan situation.

It is worth noting that ASHRAE have recently decided to omit recommended outdoor air supply rates for smoking environments from their Standard 62 because of concerns about the health effects of passive smoking. CIBSE take the view that the building services designer, whilst discouraging a client from allowing for smokers and non-smokers to work in the same space, should have the design criteria available should the client demand it. CIBSE do warn however that outdoor air supply alone may not prevent non-smokers experiencing either discomfort or long-term health effects from environmental tobacco smoke.

DUST & FILTRATION

For the first time in a CIBSE Guide a strategy is given for the use of filtration to reduce indoor air quality problems in buildings. This is treated primarily in the context of removing particulates, although reference is made to filtration equipment for the removal of gases and vapours, no design criteria are provided. CIBSE promote good quality particulate air filtration to not only reduce the pollution entering the occupied space but also to minimise the soiling of the internal surfaces of the air handling system and hence reduce the need for expensive and disruptive duct cleaning.

Criteria are provided for the specification of particulate air filters, based on those set out in BS EN 779 : *Particulate Air Filters for General Ventilation*. This standard is currently under revision for publication at the end of 1999. The test method for efficiency is being brought into line with EUROVENT 4/9, using a test aerosol and particle counter to rate filters instead of atmospheric dust and opacity measurement. A synthetic dust is used to determine the Arrestance and dust holding capacity of coarse filters.

Coarse filters are classified from G1 to G4 at a specified design final pressure drop (default value 250 Pa) and face velocity. Fine filters are classified from F5 to F9 at a specified design final pressure drop (default 450 Pa) and face velocity. The efficiency test determines an Average Efficiency (E_m %) from a number of tests at particle sizes from 0.2 to 4.0 µm. Classifications are based on the results for 0.4 µm particles, which have been found to be closest to those for atmospheric dust.

Classifications are recommended according to application. For example CIBSE recommend F6 or F7 filters be used for general offices, although if executive offices are supplied from the same air handling plant then F7 filters should be installed. An F7 filter should have an Average Efficiency for removing 0.4 µm particles of between 80 and 90%.

In addition CIBSE recommend that the following be accounted for in the selection and design of filter installations:

- Fine filters should be protected by a bank of coarse filters upstream, depending on the expected dust concentration in the incoming air. This is particularly important for locations where construction or other dust generating activities are expected nearby, and will significantly increase the life of the costly fine filters.
- Efficiency ratings apply to the entire filter installation and cannot be achieved if close attention is not paid during installation and maintenance to the fit of the filter in its frame and the frame within the air handling unit.
- Access for withdrawal of filters is essential - it is easy to damage new filters during installation if inadequate space is provided.
- Filters can become odour sources, particularly if moisture is allowed to penetrate them, hence they should be well protected from driving rain, humidifier spray etc.

CONCLUSIONS

Revision of Volume A of the CIBSE Guide is long overdue. Indeed Section A1 has not change significantly since 1976, and not at all since 1986. With the attention that has been paid to "Sick Building Syndrome", or "Building Related Sickness" as it is now more accurately termed, there has been a vast amount of research into the workplace environment, and indoor air quality in particular.

Although adherence to CIBSE Guidance will not completely eradicate this syndrome, the new guidance should represent a significant step in the journey towards improving the indoor environment.