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# BUILDING SERVICES ENGINEERING AND THE CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH (COSHH) REGULATIONS

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The COSHH Regulations are concerned with the health of employees in relation to their exposure to harmful substances, particularly airborne contaminants.

COSHH places a great deal of emphasis on the control of substances to reduce exposure. Featuring prominently under control is ventilation, whether it be dilution ventilation or localised extract.

The Building Services Engineer has an important and prominent role to play under COSHH in relation to ventilation control measures, in particular in defining performance criteria and establishing examination and testing procedures.

## INTRODUCTION

The Control of Substances Hazardous to Health Regulations (COSHH Regulations) became fully implemented on 1st January 1990. This was preceded by a considerable development period (approximately 10 years) and the original publication of the Regulations and Approved Code of Practice (ACoP) dating from 1988, HSC (1).

The Regulations and Code of Practice were drawn up on the basis of joint discussions between representatives of the Confederation of British Industry, the Trades Union Congress, the Local Authorities, Government Departments, independent experts and the Health and Safety Executive under the auspices of the Health and Safety Commission's Advisory Committee on Toxic Substances.

The Regulations essentially arise out of the Health and Safety at Work, Etc. Act 1974 which covers in broad terms responsibilities for ensuring the health and safety of employees at work. However, this Act was considered not to provide sufficient detail and enforcement in relation to the long term effects of substances hazardous to health. Hence the introduction of the COSHH Regulations, which are essentially a formalisation of detailed aspects of these 'health' considerations.

Substances hazardous to health of particular concern are those which cause occupational cancer. A recent review quoted in the COSHH ACoP suggests that 2-8% of cancer deaths each year could be prevented if occupational hazards were removed. Other sources have estimated that up to 30% of cancers are occupationally related. As there were a total of 156,236 cancer deaths recorded in Britain in 1985, the number resulting from occupational hazards is therefore highly significant when compared with fatalities in occupations resulting directly from safety aspects i.e. approximately 500 fatalities in the UK due to industrial accidents in the year 1988/1989, HSC (2).

Substances Covered by COSHH

The COSHH Regulations apply to substances which are classified as being harmful in one way or another (e.g. toxic, irritant, corrosive, etc.) under the Classification, Packaging and Labelling of Dangerous Substances Regulations 1984 and also to those substances which are listed by the Health and Safety Executive in documentation of Occupational Exposure Limits, HSE (3).

However, the physical form of a substance should also be taken into account when considering its hazards to health in practice. For instance, a lump of cadmium does not present a significant hazard on its own but when ground or heat treated, giving off airborne contamination, then entry into the metabolic system is greatly facilitated through the respiratory system, and thus the hazard to health in use (i.e. the risk) much increased.

Thus, in practice, airborne materials present the most significant hazard, these being in the form of gases, vapours and aerosols (dusts, fumes, mists, micro-organisms, etc.). Common examples found in the building services industry include asbestos fibre dust (during asbestos stripping operations), fumes from welding operations, fumes from paint stripping operations, gases and vapours from solvents and, of course, micro-organisms such as the legionella bacterium.

It should be noted that physical agents e.g. noise, heat, lighting and radiation are not involved in these regulations.

The COSHH Regulations require that any substance which presents the potential for being hazardous to health must be assessed in relation to the extent of this hazard. The assessment involves establishing the nature of the substance, the nature of the hazard, the way the substance is used at work and the degree of exposure. If the assessment indicates that exposure could be significant in relation to a hazard to health, then it is required that control measures are introduced to reduce the risk of exposure. Hence, although a great deal of emphasis in practice is put on the assessment of substances under COSHH, a most important aspect of the Regulations is the control of substances to minimise exposure.

HIERACHY OF CONTROL MEASURES

Regulation 7 of COSHH is concerned with the prevention or control of exposure to substances hazardous to health. A wide range of control options are available and the most suitable should be selected for particular circumstances.

In order of preference these control measures are summarised as follows:-

- elimination of a substance
- substitution of a substance by a less hazardous substance
- enclosing the process
- partial enclosure of process with local extract ventilation
- local extract only
- general (dilution) ventilation
- personal protection of employees including respiratory protection

together with:-

- reduction of time of exposure
- good housekeeping and handling procedures.

It can be seen that ventilation control measures lie in the middle of the order of preference and they figure strongly in terms of means of control in practice. It is always advisable, however, to attempt to reduce the inherent problem (e.g. by elimination) before resorting to any other form of control (e.g. ventilation).

Regulation 8 of COSHH is concerned with the use of control measures and states that the employer should ensure that control measures are being used on a day to day basis correctly. Also, employees should be educated to use the control measures in the ways that they are intended to be used so that exposure of the hazard is effectively controlled at all times, whether it be by ventilation, enclosure, use of respiratory protection equipment or even appropriate personal hygiene such as washing and no smoking.

Range of Ventilation Control Systems

Ventilation control can range from the least effective which is general dilution ventilation as used in the majority of conventionally occupied buildings e.g. offices, through to local extract systems for operations such as welding and woodworking equipment, to partial enclosure as with fume cupboards in chemical laboratories and full enclosure e.g. microbiological cabinets.

Control is clearly improved as the enclosure of the hazardous substances is increased and the operator is separated from the substance by physical barriers. Thus, for highly toxic materials complete enclosure is essential, whereas for relatively harmless materials local extract through slots and hoods can be employed. General ventilation is not favoured for controlling substances which have any significant hazard, but in some cases, because the place of emission of the substance is not predictable, then general ventilation may be the only solution.

The effectiveness of ventilation in relation to volumes of air handled and size of extract system is also closely linked to the effectiveness of enclosure. Figure 1 illustrates the different volumes of air which are required to extract through different forms of enclosure, each giving the same theoretical airborne control of a substance. It is seen that the partial or almost fully enclosed processes require far less rate of extract to provide the same level of control than the hoods or slots. In practice the control is also much improved because the capture of the contaminant is far less influenced by local aspects such as cross draughts, movement of people, etc.

Thus partial to full enclosure not only provides better control but better ventilation engineering design in terms of minimising capital and running costs of the system.

DETAILS OF THE SYSTEMS REQUIRED UNDER COSHH

Regulation 9 of COSHH is involved with the maintenance, examination and test of control measures. In relation to ventilation control systems much detail is given of the performance requirements and testing procedures necessary under COSHH.

Before any testing and commissioning of a system can take place, the performance criteria of the system must be defined so that figures are available for comparison purposes when the system is being quantitatively tested. Thus, a first requirement of COSHH is that the performance specification of the system is fully documented.

This has serious implications in terms of design and documentation of systems, particularly small scale systems which may be handling extract from one position only, which in many cases do not have performance specifications linked to them when they are installed. In order to comply with COSHH, it will be necessary to define the ventilation control characteristics of any system in relation to, in particular, the point of extract of the hazardous substances.

Defining Control

Control can be defined in terms of a capture velocity at a certain distance away from a certain sized hood or slot. This will be dependent on appropriate figures being selected for capture and relating the capture requirements to the natural emission characteristics and velocities of the contaminants involved. For instance, from a hot process there will be natural convection currents which will direct the contaminant vertically upwards at velocities of possibly 2-3 m/s and any capture into a ventilation system should take this into account. Alternatively, a grinding wheel will produce particles at high velocities and the capture system should employ these high velocities to assist capture (see Figure 2).

Alternatively, the definition of control may be by the face velocity into an opening or an enclosure, for instance the face velocity in the plane of the sash of a fume cupboard or the face velocity into a paint spray booth. In this case, provided data is available on suitable face velocities then the capture definition is much more clear cut.

System Characteristics

Having defined the capture characteristics then the volume flow characteristics into the system naturally result via suitable calculation, CIBSE (4). For a system with multiple extract points then all the capture points must be defined and the volume flows through the sub-branches and main branches of the system established. In defining this the dimensions and nature of ductwork will also be involved.

Velocities within ductwork must be defined in particular for systems transporting dusts (i.e. transport velocities). The type and layout of ductwork must be specified to ensure efficient transport, allow inspection and eliminate contaminant build up.

The performance of any air cleaning devices and pressure drops involved will need to be defined. The fan or air mover will require full specification and finally the exhaust point (or return air system to the workplace) will require definition e.g. via stack height and discharge velocity into the atmosphere.

Performance Testing

Once all the performance details have been established then the procedures for fully testing the system should be laid down in relation to the parameters which are required to be measured throughout the system. In general, though, the overall requirement is to establish that the performance specification is being achieved in practice.

Performance tests will involve measurements of face velocity, capture velocity, duct velocity, static pressure in the system and across fans and filters, discharge velocities, etc. The techniques for measuring the above, and the appropriate measuring positions, must all be established, together with correct procedures (e.g. for Pitot tube measurements within ductwork).

The basic performance specification and the testing and commissioning data must be methodically recorded as COSHH requires records of the performance of systems to be kept for at least five years. It is also necessary to set up a system where action will automatically result if test measurements do not tie in with the performance specification. The priority is that the control of the substance is still being effectively carried out.

The timing of the full maintenance, examination and test of systems is stated in COSHH to be at least every 14 months (which effectively means annually). Simple tests are also required, which may need to be undertaken on a daily basis for critical control systems, to ensure that the system is functioning. More thorough tests are required, perhaps once a month, and maybe a half yearly overall check to ensure that no major deficiencies are occurring in the system. The actual time scale of the intermediate testing procedures will depend on the criticality of control for the particular substance being handled. Some substances call for more frequent thorough testing, as listed in Schedule 3 of the COSHH ACoP.

## IMPLICATIONS TO THE BUILDING SERVICES PROFESSION

### A Dedicated Ventilation Systems

Possibly the greatest implication to the Building Services Profession is in relation to existing systems in industry where documentation of ventilation control systems is simply not available. In such cases professional expertise will be required to establish what performance criteria might have been used originally to establish the requirements of the ventilation system, or alternatively a fresh start will be required and new performance criteria established. This is likely to be undertaken in conjunction with an Occupational Hygienist.

The effectiveness of existing systems must be judged or measured. This may be undertaken through visual assessment of capture performance using special illumination techniques, via quantitative tests by measuring airborne levels in the vicinity of emissions with and without ventilation systems operating, and by the actual exposure to operators in practice (i.e. personal exposure) again in conjunction with a suitably qualified Occupational Hygienist.

If the existing system is considered to be performing adequately then the parameters at which it is performing must be documented, assuming that the system itself represents good design in relation to ductwork layout, resistance of ductwork, transport velocities in duct, selection and performance of fan and siting of discharge point, etc. If the system is not considered to be performing adequately then recommendations will need to be made to either upgrade or perhaps start afresh. Dimensional and layout information will also be required as it is necessary in the full commissioning and test to ensure that no changes have occurred to the hardware installed which have not been properly documented.

For newly designed systems all this information must be available at the design stage and correctly documented so that it is readily available to be used as the basic COSHH documentation. It will then be required for the first commissioning tests and the first and subsequent 14 month full examination and test.

This data would be much as required for ventilation systems in any mechanically or air conditioned building but perhaps more thoroughly than might be common practice at present. Typical commissioning details already documented in the industry (e.g. CIBSE (5); BSRIA (6)) are more concerned with supply and extract systems for general ventilation than the performance of local extract systems. There are particular characteristics of local extract systems which require further documentation, and other sources of information may need to be sought to establish for instance appropriate capture velocities, hood and booth designs, transport velocities and air cleaning systems, e.g. (4), ACGIH (7).

B General Ventilation and Hazards in Building

The COSHH Regulations clearly cover any dedicated local extract system for industrial or commercial processes but what may not be clear is whether the general ventilation system of a building is required to be assessed under COSHH in the same manner. If substances hazardous to health are used in general in the building as a whole e.g. in laboratories, where for instance the ventilation supply system to the laboratories is providing the make up air to fume cupboards, then clearly the overall ventilation system for the building would fall under COSHH as the extract system relies on a correctly operating supply system, and the general ventilation in the laboratory is required to control possible fugitive emissions.

Where the issue becomes less clear cut is, for instance, in office buildings where ventilation is required to provide appropriate conditions of comfort and health to occupants and it can be argued that the occupants may be exposed to substances hazardous to health e.g. ozone from office machinery, cigarette smoke or outgassing of building materials.

In such cases, whether the substance involved is covered specifically under COSHH may be debatable. However, if not, it is likely still to be covered in general terms under Section 2 of the Health and Safety at Work Act i.e. the requirement to provide a suitable working environment. COSHH has had the effect of re-highlighting this requirement. Also European Community Directive 89/391 (8) and associated directives is concerned with the general safety and health of workers at work, whilst certain European countries (e.g. Germany and Holland) have legislation similar to COSHH.

Thus the whole of a general ventilation system could be regarded as falling under the requirements of COSHH or equivalent, necessitating the full maintenance, examination and test at the 14 month intervals. (Alternative control measures could, however, be introduced e.g. segregation or elimination for cigarette smoking.) This should not represent a departure from the norm for a well run and well maintained building where such tests would be expected to be carried out as part of normal maintenance procedures. COSHH is essentially formalising such processes with rather more thorough documentation and record keeping than might normally be expected. There are likely, though, to be many buildings which are not correctly and fully tested on an annual basis and at some stage it may be regarded by the enforcing bodies that these measures should be enforced under the COSHH Regulations or equivalent. A time scale of such action, though, is likely to be long term as there are considerably more important areas of concern in relation to manufacturing industry as a whole and local extract type ventilation control than general ventilation in office buildings. A watching brief is necessary in this area.

Substances hazardous to health in the form of micro-organisms are also potentially present in water systems e.g. Legionnaires' Disease associated with cooling towers and hot water systems. In such cases risks of exposure to workforce operating or maintaining such equipment should be covered under COSHH by adequate control procedures (usually via personal protection). Exposure to the general populus would more likely be covered by the Health and Safety at Work Act. However, the subject of Legionellosis is shortly to be covered by specific legislation in the UK, HSC (9).

C Information, Instruction and Training

In relation to the 'expertise' provided when implementing COSHH, the Regulations place a great deal of emphasis on the appropriate competence of the persons involved in their field of expertise.

The meaning of this term is not defined, but substantiation in practice is usually provided by the appropriate combination of academic and professional qualifications. However, these do not necessarily demonstrate that current experience or specialism is held in a particular field in the profession (e.g. expertise in local extract design). There could thus be a requirement for additional technical/legal input on standard engineering courses, specialist short courses, appropriate continuing professional development and professional registration systems for specialist areas within the building services profession, as applies with the profession of Occupational Hygiene both in the UK and USA.

Great emphasis is also placed in COSHH on the appropriate provision of information, instruction and training to operators in industry who rely on ventilation systems for appropriate control of exposure to substances. Laboratory workers operating fume cupboards is an obvious example. Such a provision is likely to lead to the need for formalised short courses, and in house training schemes for operators which could be conducted by the appropriate competent specialists (e.g. building services engineers) previously referred to.

## CONCLUSIONS

The COSHH Regulations are a formalisation of the responsibilties of employers to reduce exposure of employees to hazardous substances. They also serve to highlight the employers general duty to provide a safe and healthy working environment.

Much emphasis is placed in COSHH on the control of hazardous substances. Ventilation control is of particular importance in relation to airborne contaminants, whether by local extract or general dilution ventilation.

The Building Services Engineer has an important and prominent role to play under COSHH in relation to defining both the performance criteria of ventilation control systems, and establishing appropriate procedures for their maintenance, examination and testing. This role may extend to general ventilation systems in buildings such as offices and to participation in the provision of appropriate information, instruction and training.

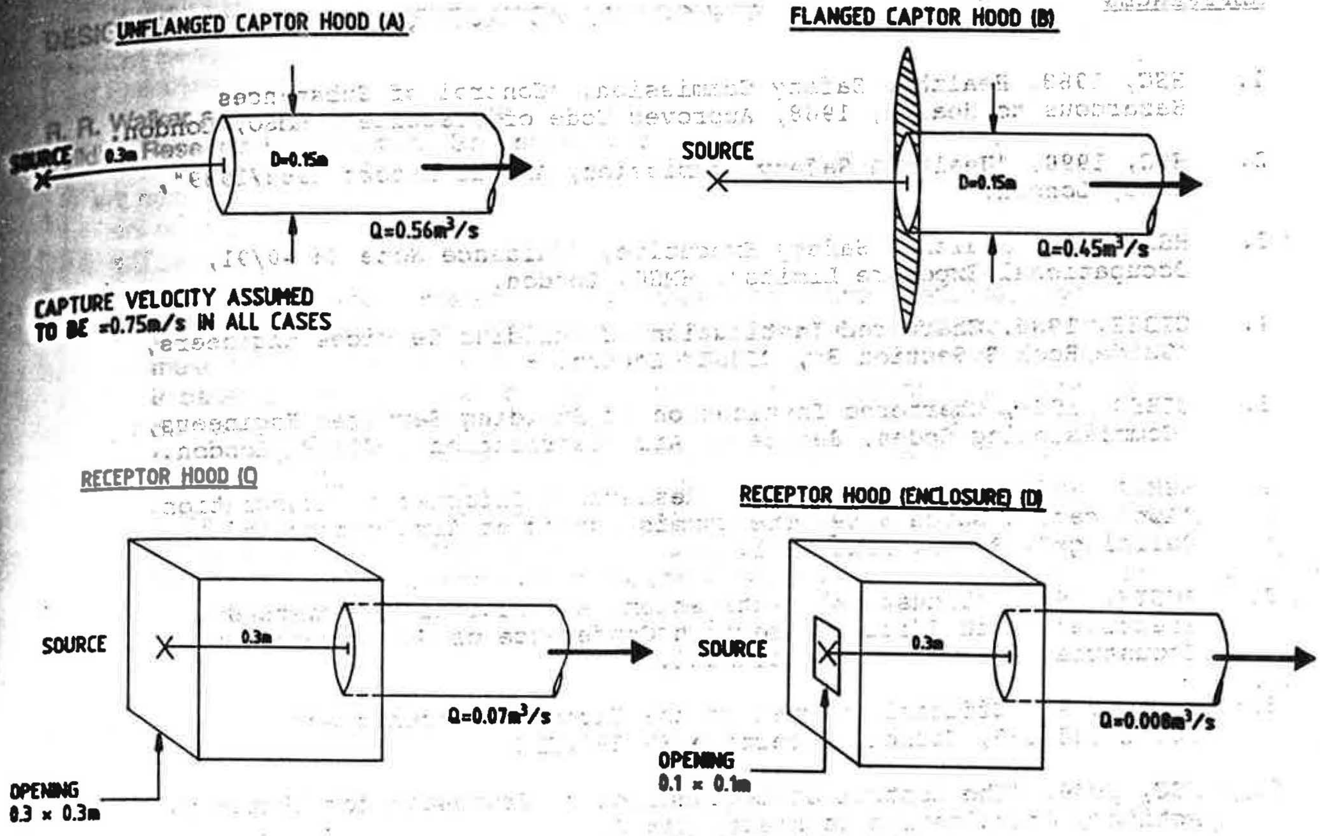


Figure 1 A comparison of different capture/receptor hoods. The theoretical capture performance of each example is identical; the ductwork volume flow decreases significantly from example (A) to (D). Adapted from BOHS (10).

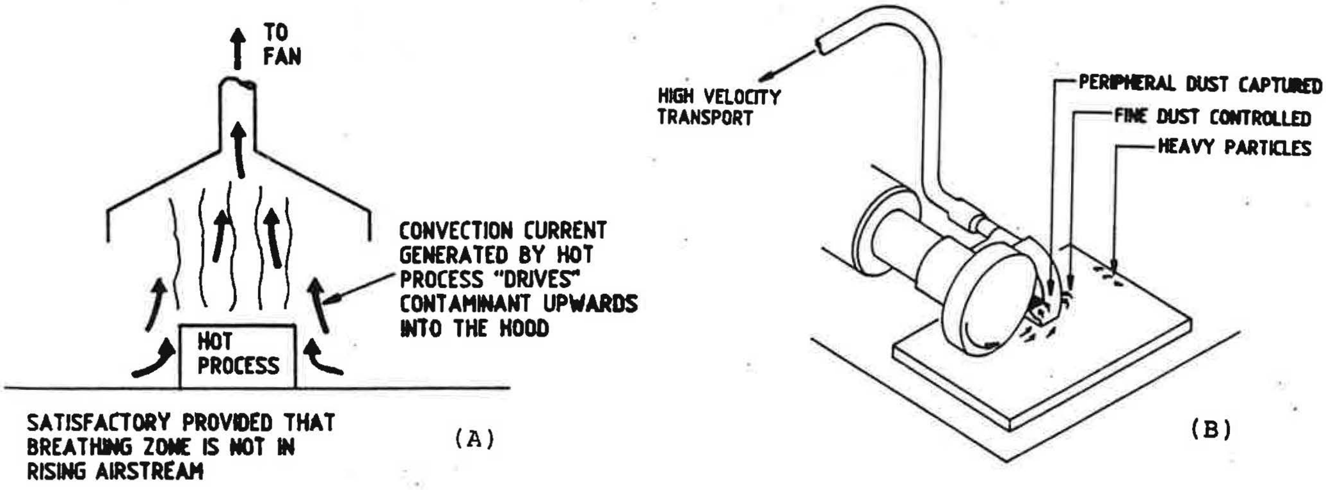


Figure 2 Examples of using the natural emission velocity of contaminants to assist in their capture.
A : Hot process - gases/vapours
B : High velocity particles from grinding wheel

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