

Safety Code of Practice 14

Part 6

Control of Biological Hazards

Microbiological Safety Cabinets



University of Reading Safety Code of Practice 14 Part 6

Microbiological Safety Cabinets

Contents

Summary	ii
1. Introduction	3
2. Responsibilities.....	3
1.1 Duties on managers.....	3
1.2 Duties on staff who use Microbiological Safety Cabinets.....	4
3. Types of Microbiological Safety Cabinet and ventilation systems	5
1.3 Types of Microbiological Safety Cabinets.....	5
Class I cabinets.....	6
Class II cabinets	6
Class III cabinets	8
4. Protection for the work – laminar flow cabinets	8
5. Ventilation arrangements for MSCs.....	8
6. Cabinet selection.....	9
7. Safe use of safety cabinets.....	11
8. Training	12
9. Maintenance and Testing	12
1.4 Maintenance and inspection of external fans and ducting.....	13
10. Cabinet fumigation.....	14
1.5 Formaldehyde fumigation.....	14
1.6 Vaporised hydrogen peroxide systems.....	16
1.7 Validation	16
1.8 Disposal of filters	16
11. Selection, siting and installation of cabinets	17
12. Further information	19

Gretta Roberts
Health and Safety Services
Office of the University Secretary
Issue 3
October 2012

Microbiological Safety Cabinets

Summary

- 1 Microbiological Safety Cabinets (MSCs) are normally used to protect workers from exposure to biological agents, and, as such, are considered to be "control measures" under the Control of Substances Hazardous to Health (COSHH) Regulations. As a form of local exhaust ventilation (LEV), they require a thorough examination and test at regular intervals.
- 2 All users of MSCs must be trained in the proper safe use of each cabinet they work with. They should be able to demonstrate their competence in the use of the cabinet before undertaking work with hazardous biological agents within the cabinet.
- 3 All MSCs should meet the construction and performance criteria of the relevant Standards, both on installation prior to use, and following any maintenance.
- 4 Before any cabinet used with hazardous biological agents is subjected to the "*thorough examination and test*", it must be rendered safe for the examination and testing to be carried out.
- 5 All records of examination and test must be kept for a minimum of 5 years, and be readily available for inspection if required. As MSCs are School/departmental equipment, it is the responsibility of the School/department to keep these records.

1. Introduction

This Part of Safety Guide 14 “Control of Biological Hazards” sets out the technical and management requirements relating to the safe use of Microbiological Safety Cabinets (MSCs) when these are used to protect workers from exposure to aerosols of viable biological agents. As such, they are regarded as a form of Local Exhaust Ventilation (LEV) under the Control of Substances Hazardous to Health Regulations (COSHH), and are subject to the requirements for regular examination and testing specified by the Regulations.

Microbiological Safety Cabinets (MSCs) are designed to protect users and the environment (including other people in the laboratory) from aerosol risks arising from handling hazardous biological material. Some types of cabinet are also designed to protect the materials being handled within them from environmental contamination. Air discharged from the exhaust of the cabinet is filtered to remove microbiological contamination and is either ducted to outside or re-circulated into the laboratory.

Microbiological safety cabinets are not designed to protect the user from all hazards e.g. radioactive, toxic or corrosive hazards, and the exhaust HEPA filters will not remove these types of contaminants from the air. Particular care must be taken when using materials with such additional hazards to ensure these are not discharged into the laboratory environment from cabinets that are not externally ducted.

This guide does not cover the use of nanotechnologies in safety cabinets. This information will be available in a separate Safety Code of Practice.

2. Responsibilities

2.1 Duties on managers

Heads of relevant Schools and other managers must ensure that:

- One or more individuals are designated to have overall control over the microbiological safety cabinets in their area. Any of the duties described below may be delegated to the designated individual(s), but the responsibility remains with the Head of School.
- Whenever a new cabinet is installed, or an existing cabinet is repaired, serviced or moved to a new location, that it passes an **“in use” containment test** by a competent engineer **before** it is permitted to be used with hazardous biological agents.
- All MSCs are subject to a programme of regular examination, maintenance and testing. Testing must only be undertaken by a “competent person”, *i.e.*, someone with the appropriate knowledge and experience to undertake the test. This is normally an engineer from the manufacturer, or a company specialising in the service and maintenance of MSCs.
- A system is established to record:
 - the location of each MSC

- the results of every examination and test (plus details of any maintenance undertaken).
- All users of MSCs are trained in the safe use of those cabinets they will use, and that records are kept of the training.
- All users are instructed to promptly report any faults which affect the proper functioning of a cabinet to a designated person, who will arrange for the cabinet to be taken out of use, and arrange for a proper repair to the cabinet.
- One or more individuals are appointed and properly trained to oversee and/ or effect the decontamination of cabinets prior to a visit by an engineer to carry out the servicing, examination and test of the cabinet.

1.2 Duties on staff who use Microbiological Safety Cabinets

- All staff wishing to use a microbiological safety cabinet (MSC) with viable biological agents must receive appropriate training to be able to use the cabinet safely.
- They should use the cabinet in accordance with the training they have received.
- They must promptly report any fault conditions within the cabinet to the designated person, and as far as possible, render the cabinet “safe” before closing the cabinet and posting a “Faulty – Do Not Use” sign on the cabinet in a prominent position.

3. Types of Microbiological Safety Cabinet and ventilation systems

1.3 Types of Microbiological Safety Cabinets

The principle of operation of any MSC is to create a working area that is held at negative pressure relative to the surrounding laboratory, and to protect the worker by ensuring that air contaminated by an aerosol of a viable biological agent is directed away from the worker's breathing zone.

All MSCs consist of a physical "containment chamber" in which work with the potential to disperse hazardous microorganisms is performed. Any aerosol is removed from the cabinet by extracting the air from the cabinet, and filtering it through a high efficiency particulate air (HEPA) filter before discharge.

There are three main types of MSC, open-fronted (Class I and Class II) or closed (Class III).

Table 1: Types of Microbiological Safety Cabinet

Class I	Are effectively fume cupboards with the addition of a High Efficiency Particulate Air (HEPA) filter on the exhaust, and are designed to prevent dispersal of contaminated aerosols into the environment of the laboratory or outside the building. The exhaust air is ducted to outside air. They offer worker protection, but do not protect the work from contamination as they pull in a flow of unfiltered air which passes over the working area, then is discharged, normally through a single HEPA filter to the exterior of the building.
Class II	Combine the worker protection benefit of a working environment held at negative pressure, with the work protection benefit of bathing the work area in a flow of "sterile" (HEPA filtered) air. Class II cabinets may either be ducted or discharge filtered air into the laboratory.
Class III	Protect both the worker and the work by ensuring that the work is undertaken in a "sealed box" which is held at negative pressure and where the work is also bathed in a flow of sterile air. The operator has to use arm-length gloves which are sealed to the front of the cabinet. . The exhaust air is ducted to outside air.

There are various classes of HEPA filter, normally manufacturers of MSCs would install filters to class H14, designed to retain not less than 99.995% of challenge particles.

Care must be taken on selecting the correct choice of cabinet and ducting arrangements for the type of activity it is going to be used for. See section 11 and Figure 4 for further information.

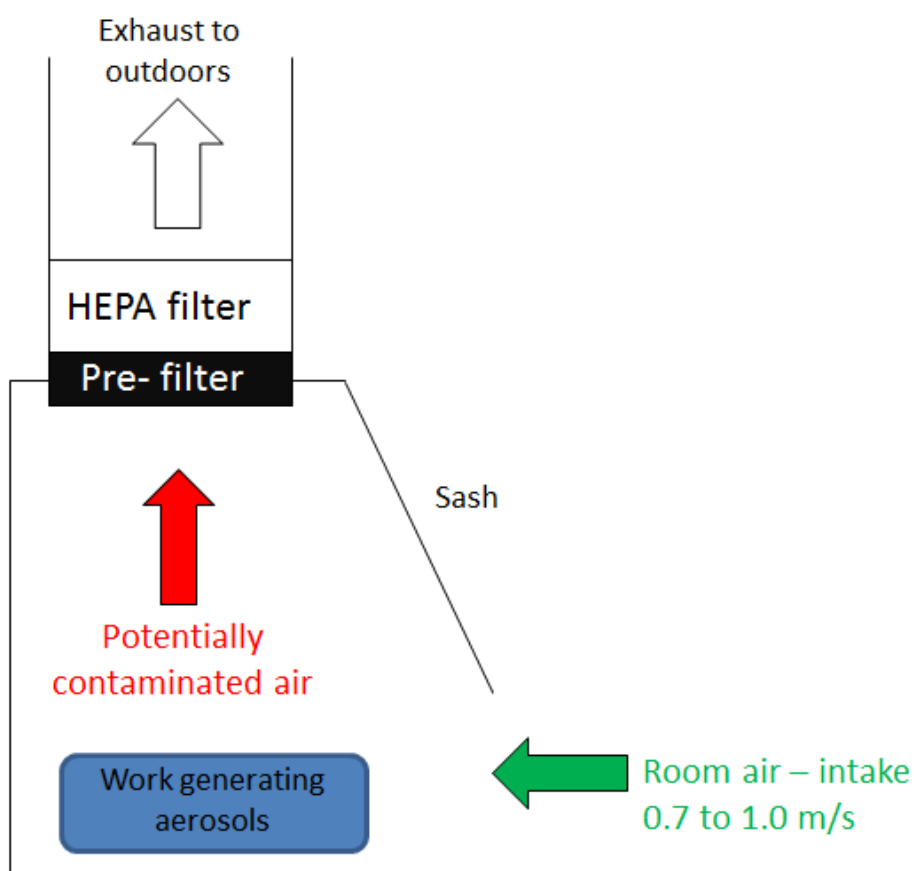
In some designs of cabinet, the filters are designed for easy replacement without the risk of exposure to organisms retained on the filter. Such "safe-change" filter installations are recommended in cases where fumigation of the cabinet might be ineffective or difficult to achieve.

Class I cabinets

Typically these cabinets do not have a moveable sash at the front of the cabinet, but have a fixed aperture. The aperture can be closed off with a "night door" when the cabinet is not in use.

The inward air velocity should be between 0.7 and 1.0 m/sec. over the whole of the front aperture of the cabinet.

Figure 1: Schematic diagram of airflow in a Class I MSC



Class II cabinets

Class II cabinets protect both the worker, and the work being done. Contamination of the work is prevented by a sterile curtain (downflow) of HEPA-filtered air from the ceiling of the cabinet. This sterile air bathes and protects the work from airborne contaminants. Non-sterile makeup air is drawn in through the front of the cabinet at a relatively low velocity (to avoid disrupting the air curtain), and is directed, via special baffles and perforations in the front lip of the cabinet, below the main working platform of the cabinet. In most European designs, all of the air is then passed through a HEPA filter, with about 70-80% of the air being recirculated within the cabinet (as the downflow of "sterile" air). 20-30% of the air is discharged, either directly outside (ducted) or back into the laboratory. Some cabinets are fitted with two in-line HEPA filters as an additional precaution against filter penetration. If

this is the case, the cabinet design must be such that the filters can be tested independently of each other.

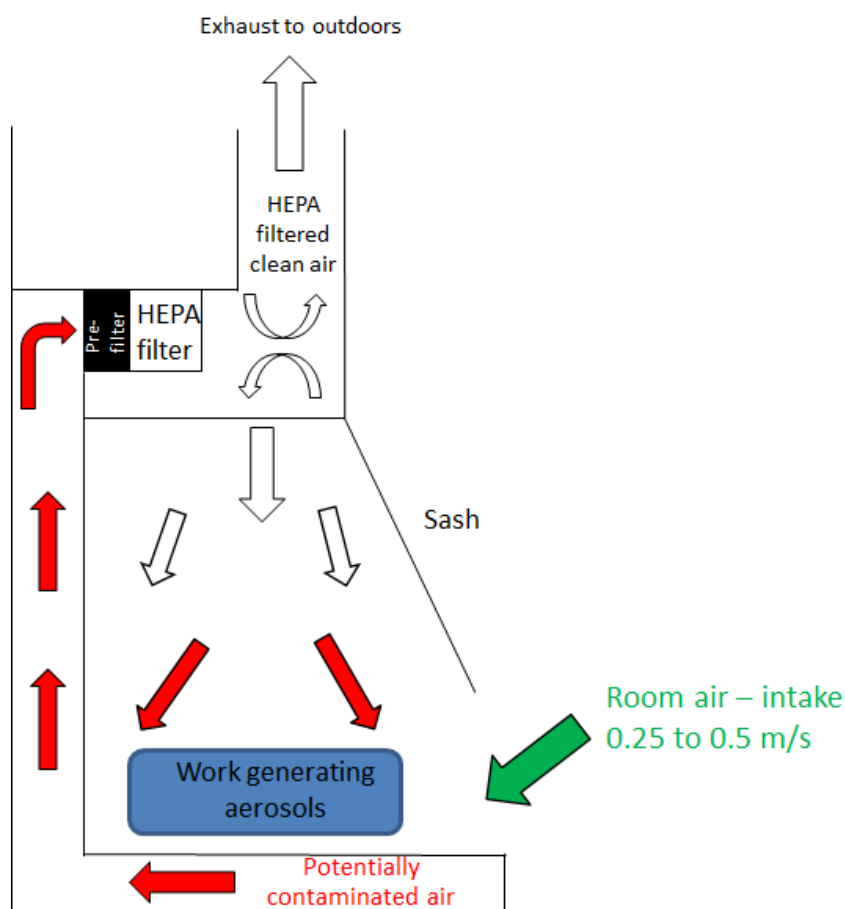
Inflow air should have a mean inward air velocity of not less than 0.4 m/sec, whilst the downward air velocity should be between 0.25 and 0.5 m/sec.

Because the inward air velocity is low, the cabinet will only capture particles or droplets emitted with a velocity less than 0.4 m/sec. Thus, any operations (especially at the front of the cabinet) that create particle velocities greater than this may result in particles being emitted from the front of the cabinet. In addition, the cabinet is very sensitive to eddy currents in the air in and around the cabinet.

Bunsen burners should **never** be used in a Class II safety cabinet.

Class II cabinets are also very sensitive to their position within the laboratory. Other cabinets, fume cupboards, air inlets and extraction points can seriously degrade their performance if they are too close. Other places to avoid include through routes and frequently-opened doors, where frequent movement of personnel can create excessive air movements.

Figure 2 Schematic diagram of airflow in a Class II microbiological safety cabinet



Class III cabinets

Class III cabinets consist of a sealed “box” fitted with access ports and arm-length rubber gloves to allow the worker to manipulate material in the cabinet. The cabinet provides complete isolation of the work from the worker, and protects the work being done, provided that the seals and integral gloves are intact.

There are no Class III cabinets in use at the University. Further details of Class III cabinets can be provided from H&S Services if required.

4. Protection for the work – laminar flow cabinets

In some cases, MSCs are used solely to protect the work rather than the worker (e.g. for plant cell culture), and formally do not come within the remit of the COSHH Regulations.

It should be noted that **vertical laminar flow cabinets** show a superficial resemblance to Class II MSCs. Such cabinets do not offer any user protection as they are designed simply to protect the work by bathing it in a downwards flow of sterile air. This air spills out of the front of the cabinet towards the operator’s breathing zone, and any biological agents present would be directed towards the operator. Laminar flow cabinets must never be used with viable biological agents, or any materials liable to cause respiratory sensitisation.

All such cabinets must be marked “This is not a Safety Cabinet, and must not be used with viable biological materials”.

5. Ventilation arrangements for MSCs

It is good occupational hygiene practice to discharge the exhaust air from MSCs to the outside. Within the University the following approaches should be taken:

- In containment level facilities, venting via a HEPA filter through a window or wall to the same level is acceptable, provided attention is paid to the position of nearby opening windows, doors or air intakes. This may also be affected by planned chemical usage. If toxic chemicals or radionuclides are to be used, cabinets must be discharged to air above roof height.
- In containment level 3 facilities, cabinets must exhaust via a HEPA filter to the outside. The output duct must be taken to above roof level.
- If it is not possible to vent to the outside, a re-circulating cabinet may be considered in CL2 facilities providing there are no other hazardous contaminants in the discharged air. Consideration must be given to a safe method of fumigating the cabinet.

Where the cabinet is ducted out of the room, the ductwork must be appropriately labelled, and fitted with fire-resisting dampers that can be closed when the room is fumigated. A visible non-return valve should be fitted if the cabinet relies on the building extract to **pull** the filtered air out of the cabinet, an extraction thimble must be used if the cabinet fans **push**

the filtered air into the building extract system. Where thimble systems are in place, the building extraction must be such that more air is extracted from the room via the thimble than the cabinet is capable of expelling, so that the exhaust air from the cabinet is entrained in the general extract from the room via the thimble.

Where the cabinet is used at Containment Level 3, the room supply, cabinet extract and any duct or roof-mounted fan should be interlinked so that the air supply will cut off and the alarm sounds if the extract fan fails. This is to avoid positive pressurisation of the room.

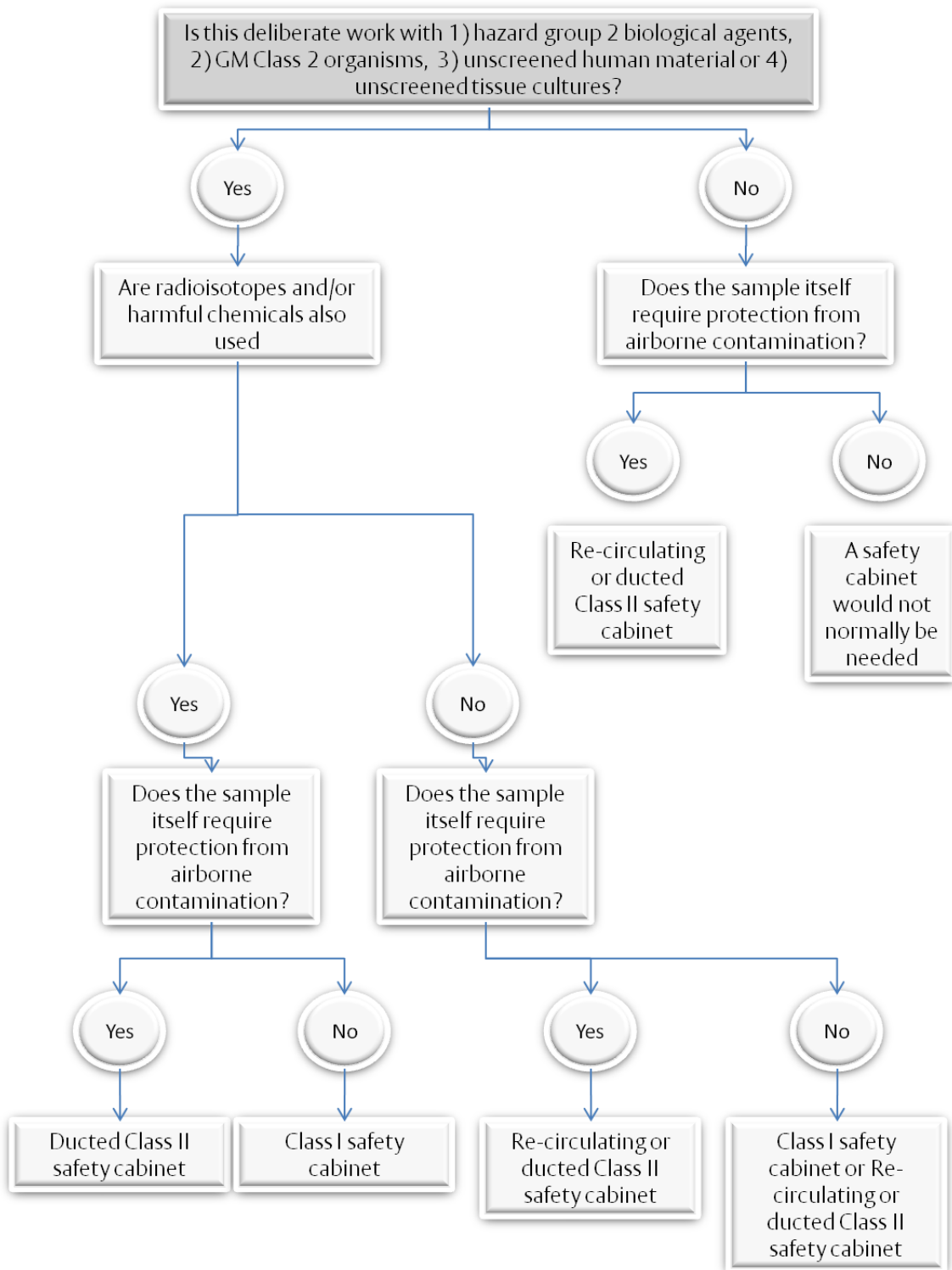
6. Cabinet selection

A risk assessment should be undertaken to determine the Class of cabinet appropriate for a particular work activity, taking into account the ducting arrangements. This should consider the nature of the potential hazards in terms of not only the microorganisms involved and their route of infection but also the techniques to be carried out, any other hazards and whether protection of the work is needed. **The class of cabinet required is not linked to the containment level assigned to the work.**

Class I cabinets should be used if procedures within the cabinet are likely to generate a significant aerosol and or disrupt the air flow pattern within a class II cabinet and so compromise operator protection. Class I cabinet would be preferentially selected over a Class II for work with certain pathogens that infect via the airborne route.

The following flow diagram provides further guidance on the selection of the correct MSC for a task. For purchasing and installation of a new cabinet please see further details in Section 11.

Figure 3: Selection of the correct Microbiological Safety Cabinet



7. Safe use of safety cabinets

1. Before using a cabinet, the fans should be switched on and run for 2-5 minutes to allow the conditions to stabilise.
2. Alarms must not be muted, and correct operation (in terms of airflow) confirmed by reference to the airflow meter usually fitted to the extraction system for the cabinet.
3. Perform operations as close to the middle of the cabinet as possible.
4. Avoid excessive movement of materials and arms through the front of the cabinet; when you do enter or exit the cabinet allow the cabinet to stabilize before resuming work.
5. Keep the work area clean and tidy.
6. If the alarm sounds during work make the work secure e.g. seal tubes, if the cabinet air flow fails during use seal the front with the night door, switch off and clearly label and contact the laboratory manager.
7. Any spills of viable biological agents within the cabinet must be promptly treated with a suitable disinfectant.
8. The UV lamp, if fitted, should never be on while the cabinet is in use.
9. After using a cabinet with viable biological agents, at the end of the working day, the cabinet should be run for at least 5 minutes, to assist the removal of residual contaminated aerosols.
10. All parts of the working area of the cabinet should then be swabbed with a suitable disinfectant (as recommended by the cabinet manufacturer). Swabbing with 70% Ethanol is often recommended for this, but it may presents a serious risk of fire if there are any naked flames or sources of ignition in or near the cabinet.

Where UV lights are installed in MSCs, electrical interlocking must be fitted and operational to prevent direct operator exposure to UV light.

8. Training

It is important that users of microbiological safety cabinets are trained in correct use, not only in order to understand how the cabinet works but also because poor technique can compromise the operation protection afforded by the cabinet.

Training should cover:

- Principles of how the different classes of cabinets work including airflow patterns, suitability of different cabinets for particular types of work
- Principles of airflow and limitations of cabinet performance
- How to work at cabinets safely
- Operation and function of all controls and indicators
- How to decontaminate the cabinet after use and requirements for fumigation, and, where appropriate how to do this.

Users must be able to distinguish between laminar flow cabinets and microbiological safety cabinets, and **never** use the former for work with viable biological agents, as they are not designed to nor do they offer any protection to the user.

9. Maintenance and Testing

Where a safety cabinet is used as a “control measure” in terms of the COSHH Regulations, it must be regularly subject to “thorough examination and testing” at intervals not exceeding 14 months (in practice, this means annually) (COSHH Regulation 9). Additional guidance is provided in the ACoP The management, design and operation of microbiological containment laboratories and in Part 3 of the SACGM Compendium of Guidance. The frequency of examination and test of any individual cabinet should be determined on the basis of a risk assessment.

The table below is intended to assist with risk assessment process based on the following cabinet usage hazard levels:

- **Low** – can include MSCs located in containment level 2 laboratories if used only for established culture collections presenting a low-infection risk or for primary lab animal cell culture;
- **Medium** – HG2 or GM class 2 activities, work with human or wild/farm animal materials including primary cell culture;
- **High** - used with organisms in hazard group 3/class 3 GM or with HG2/Class 2 organisms which present a particular hazard of infection by the aerosol route.

Before servicing a cabinet it must be rendered safe, this may include fumigation or surface decontamination. See section 10.

Table 2: Inspection and test requirements

	Class I			Class II		
	Low	Medium	High	Low	Medium	High
Alarms and indicator check	Every use – by user During each maintenance – by contractor			Every use – by user During each maintenance – by contractor		
Face velocity/inflow	Annual	Monthly*		Annual	Monthly*	
Inflow/downflow	Not applicable			Annual	Monthly*	
Filter integrity tests	Annual	6 monthly		Annual	6 monthly	
Mechanical and electrical function	Annual	6 monthly		Annual	6 monthly	
Mechanical integrity (including visible ductwork)	Annual			Annual		
Operator Protection Factor*	Annual	Annual	N/A	Annual	Annual	N/A
In use operator protection factor*	If required	If required	6 monthly	If required	If required	6 monthly

* Carried out by a trained local responsible person.

*Operator Protection Factor (OPF) is a measure of the degree of protection provided to an operator of an open-fronted microbiological safety cabinet when particles are released inside the cabinet. Numerically, it equals the ratio of the number of particles on either side of the protective device, *i.e.*, inside and outside the cabinet. Operation protection factors must be above 1×10^5 .

All tests should be carried out under conditions as representative as possible of normal working conditions *i.e.* with any air conditioning units or other ventilation systems in the lab switched on; with other safety cabinets and fume cupboards within the laboratory switched on, with the cabinet loaded with a typical arrangement of equipment and samples, with a person moving around the laboratory, particularly if any pedestrian traffic is near the cabinet and with doors being opened and closed.

1.4 Maintenance and inspection of external fans and ducting

Where ducted “pull” fans are used to operate the airflow of microbiological safety cabinets, these must be under the scheme for planned preventative maintenance (PPM) together with all associated duct work. These systems fall under the remit of Estates and Facilities. It is essential that PPM on fans and ductwork is notified in advance to owner Schools, in order to take the system out of use and a permit to work issued.

10. Cabinet fumigation

If Microbiological Safety Cabinets have been used for work with hazardous micro-organisms, they must be fumigated in the following circumstances:

- after a major spillage or a spillage where inaccessible surfaces have been contaminated
- before any maintenance work on the cabinet where access to potentially contaminated parts is necessary (including filter and pre-filter changes)
- before carrying out filter penetration tests
- when there are any changes in the nature of the work that result in significantly different risks.

Agents causing the Transmissible Spongiform Encephalopathies are resistant to inactivation by formalin and alternative decontamination procedures are required. Further advice is available from the University Biological Safety Advisor.

Fumigation must be carried out only by a trained responsible person with adequate knowledge of the procedure and the precautions to be followed. A detailed risk assessment and Standard Operating Procedure (SOP) must be in place.

1.5 Formaldehyde fumigation

Fumigation with formaldehyde vapour is the recognised and most commonly used method for this type of fumigation procedures.

Formalin is a commercially available 40% solution of formaldehyde vapour in water. When formalin is heated formaldehyde vapour is generated in quantity. Formaldehyde is a Schedule 1 chemical under the COSHH Regulations and has a Workplace Exposure Limit (WEL) of 2 ppm (or 2.5 mg/m³).

Under certain conditions formaldehyde can react with hydrochloric acid and chlorine-containing disinfectants, e.g. hypochlorites, to form bis (chlormethyl) ether, a potent lung carcinogen. Hydrochloric acid and chlorine-containing disinfectants must therefore be removed from Microbiological Safety Cabinets before fumigation.

During fumigation, the fumigant must be able to penetrate to all parts of the cabinet, including the ductwork on both sides of the filter, the fan housing and all parts of the working area. To prevent escape of fumigant into the room, the cabinet must be sealed before fumigation starts (for open-fronted cabinets, the "night door" is put in place). The cabinet manufacturer's instructions should be followed. Where necessary, sealing tape should be used to ensure there is no leakage. In order to ensure adequate penetration of the HEPA filter, in the absence of specific instructions by the cabinet manufacturer, the cabinet fans should be turned on for 10-15 seconds after about half the formalin has been evaporated. Many cabinets are now fitted with "formalin vaporisers", which make fumigation relatively easy. However, some older cabinets have no such provision, and other arrangements have to be made for fumigation.

Where a cabinet vaporiser is not fitted, the technique used for formalin evaporation should minimise potential exposure of all personnel to the gas: ideally, a thermostatically controlled electric heating mantle should be used. The use of potassium permanganate to create the gas should be avoided, as it is difficult to control the rate of evolution of the gas, and, once started, cannot be stopped.

Cabinet fumigation is straightforward for any cabinet that has the exhaust air permanently ducted to the outside of the building. However, special arrangements will be required for "recirculating" cabinets, where the discharged air would be returned to the laboratory. There are two main options:

- Flexible "elephant's trunking" ductwork to safely remove any fumigant - the trunking could be directed into a fume cupboard, or out of a convenient window. If a window is chosen, the window must not overlook an area such as a central well in a building where the discharged gas could accumulate. All adjacent windows must be sealed shut to prevent any formaldehyde from re-entering the building.
- neutralise the formaldehyde with ammonia, so that discharge to the environment is avoided.

Formaldehyde MUST NOT be recirculated into the laboratory under any circumstances.

For formaldehyde to act to maximum effect it must be able to penetrate (pre-cleaning is helpful if it can be done without jeopardising safety). It must be able to dissolve at adequate concentrations in a film of moisture in the immediate vicinity of the organisms to be inactivated. Water vapour generated in the process of dispersing formaldehyde provides the essential optimum level of relative humidity and so it is important to ensure that water is added to the formalin prior to vaporisation. Too much formaldehyde results in the deposition of sticky deposits of paraformaldehyde and in cabinets may contribute to filter blockage. The amounts of formalin and water required for fumigation are given below.

Fumigation is most effective above 20°C and relative humidity of 65%. Below 18°C formaldehyde fumigation is less effective. Below 9°C, formaldehyde sublimates and is less easy to vaporise.

Table 3: Typical quantities of formalin required for fumigation of the different types of cabinets

	Volume of 37-40% (w/v) Formaldehyde	Volume of Water
Class I cabinet	20 ml	20 ml
Class II cabinet (1200 mm wide)	25 ml	25 ml
Class II cabinet (1800 mm wide)	30 ml	30 ml

Formaldehyde should be left to disperse within the cabinet for at least six hours, after which time the fumigant should be exhausted to atmosphere by switching on the fan and allowing air from the room to enter the cabinet. Before venting the formaldehyde in this way it is essential to ensure that no one is in the vicinity of the exhaust outlet. The cabinet should be left running to purge the cabinet of formaldehyde for at least 2 hours.

Whilst fumigation is in progress a large notice must be posted on the front of the cabinet to warn that the cabinet is being fumigated. During fumigation access to the room should be restricted.

A risk assessment and standing operating procedure must be in place for cabinet fumigations, including contingency plans. All persons carrying out cabinet fumigations must receive documented training on the above documents.

1.6 Vaporised hydrogen peroxide systems

An alternative system to formaldehyde is to use vaporised hydrogen peroxide (VHP). VHP systems claim the advantage that the overall time taken to achieve decontamination is reduced, as the residual VHP can be removed catalytically by conversion to water and oxygen (thus, no need to discharge to the exterior of the building), and there are no toxic or potentially carcinogenic by-products from the operation. VHP systems can either be purchased, or a fumigation service may be provided by a specialist contractor.

1.7 Validation

Whatever system is chosen for decontamination, it must be properly validated – such validation is normally done with spore strips, which are placed at various locations within the cabinet. Effective fumigation is shown by failure to recover viable spores from the strips after fumigation.

1.8 Disposal of filters

Where the cabinet has been used for hazardous micro-organisms, HEPA filters should be handled only with appropriate protective clothing, even after fumigation. After fumigation, filters must be disposed of as hazardous waste.

11. Selection, siting and installation of cabinets

Factors which should be borne in mind when selecting a cabinet for particular types of work will mainly depend on any need to protect the work as well as the worker. If it is essential that the work be protected - as for example, when using cell cultures - then a Class I cabinet is unlikely to be the first choice. A Class III cabinet will protect both the work and the worker, but as noted earlier, requires specialist training, and can be very restrictive in use. In many cases, therefore, a Class II cabinet will be selected.

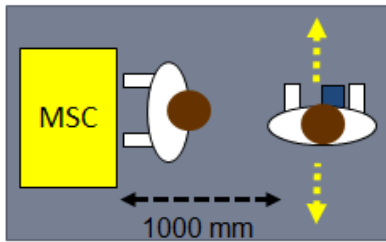
The siting of microbiological safety cabinet is extremely important. Air currents and movement of people in the laboratory can adversely affect the performance of a cabinet. Factors to be considered include the proximity of cabinets to doors, windows, ventilation ducts and to movement routes. Positioning of new cabinets within laboratories should meet the guidelines set out in BS5726: 2005. For new cabinets the supplier should visit the site, undertake a site survey and advise on installation and meeting BS requirements prior to purchasing. Cabinets must be properly installed and commissioned. Prior to use the cabinet must pass the performance tests specified in BS EN 12459.

These requirements also apply when cabinets are moved or relocated.

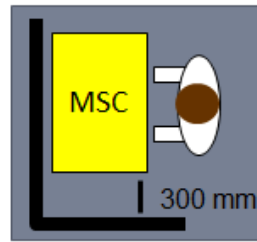
After installation, after servicing or being moved, all open-fronted cabinets should be tested to make sure that the requisite operator protection factor is achieved **during use** (see above).

Figure 4 indicates the requirements that should be taken into account when choosing a location for a MSC in the lab (taken from BS 5726: 2005).

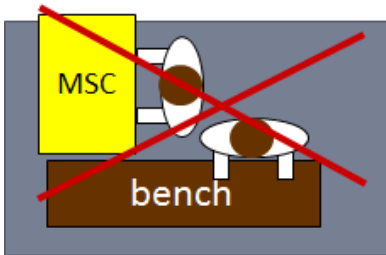
Figure 4 Correct sitting of microbiological safety cabinets



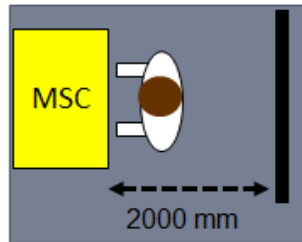
Pedestrian traffic should be at least 1000mm from the front of the MSC



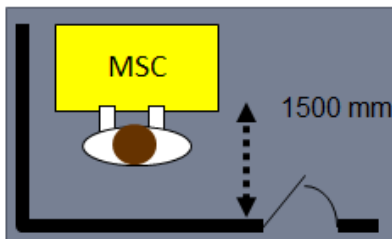
An MSC should not be positioned with either side closer than 300mm from a wall or similar obstruction



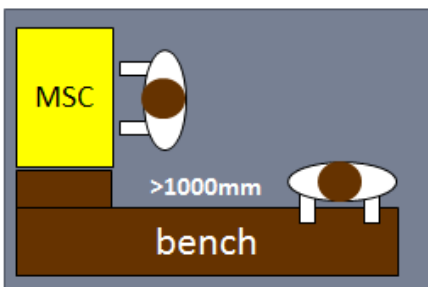
A bench at right angles to an MSC may lead to a person working at that bench to cause disturbances in air flow



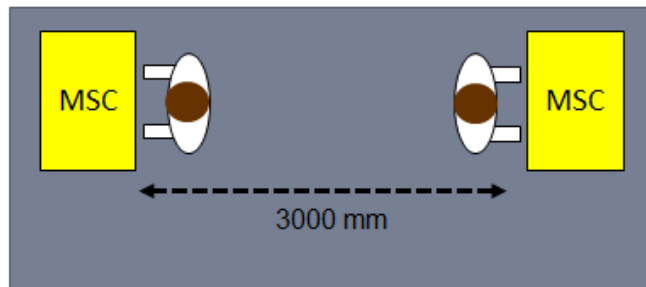
There should be no opposing wall within 2000mm of the front of an MSC



Doorways should not be situated within 1500mm of the front of an MSC or within 1000mm of the side of the cabinet. The only exception is when a door includes air transfer gills. Testing should be carried out to ascertain a suitable distance. Opposing benches should not be situated within 1500mm of the front of a working cabinet



ABOVE: A projecting bench will help to keep traffic clear of the MSC. Work at the bench will have little effect on air flow if sited at least 1000mm from the side of the cabinet



ABOVE: The distance from the front of an opposing MSC or fume cupboard should be at least 3000mm

12. Further information

- British Standard BS EN 12469:2000. *Biotechnology: Performance criteria for microbiological safety cabinets*. British Standards Institution, London and Milton Keynes.
- British Standard BS 5726: 2005. *Microbiological safety cabinets: Information to be supplied by the purchaser to the vendor and to the installer, and siting and use of cabinets*.
- *The Management, design and operation of microbiological containment laboratories*, Health and Safety Commission/ Department of Health, Advisory Committee on Dangerous Pathogens. HSE Books, Sudbury, 2001. ISBN 0 -7176-2034-4.