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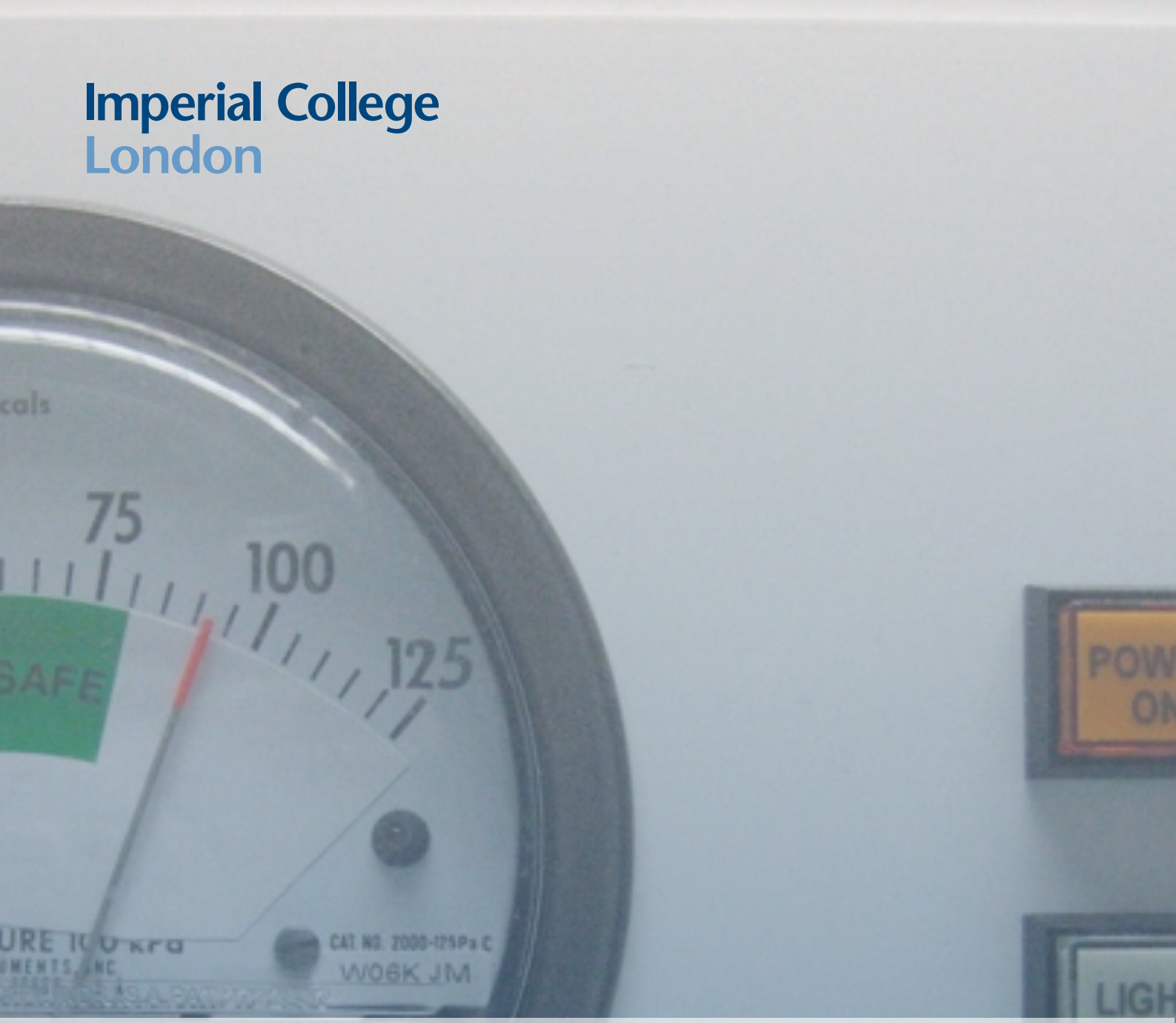

Code of Practice

Selection, use and maintenance of Microbiological Safety Cabinets

version 2.0

REVISION LOG

DATE	REVISION	PAGE
2005	Code of Practice first released	All
July 2011	Relaxation of the mandatory requirement for safety cabinet signage as described in Appendix B	9
"	Anemometer supplier advice amended	20
"	Monthly airflow testing requirement relaxed for certain work from mandatory to subject to risk assessment	20
"	Class II cabinet monthly airflow testing SOP revised to include for inflow measurement	30
"	Reference to new College Policy on Local Exhaust Ventilation inserted	5
"	Reference to VHP as potential fumigant removed	18
"	Details on the requirement for information at handover inserted	14
"	Form MSC1 (see Appendix C) modified so as to reaffirm that this pertains to a risk assessment for the disinfection of MSCs only. It does not refer to decontamination eg of radioisotopes as this is dealt within activity risk assessments	26
"	Statement of requirement for fumigation before filter changes when cabinet is used for Hazard Group/ Class 2 or 3 work	22
"	Inserted section on Energy saving measures	10
"	Clarified the statement on the electrical safety and the conflict between EN61010 and the IEE Regs	10
"	Inserted cabinet ducting guidelines	11-12
"	Inserted section on the responsibilities	6+
"	inserted a statement regarding the requirement for double HEPA filtration on the exhausts to recirculating MSCs used for certain work	9
"	Inserted a requirement for duct pressure testing by cabinet engineers	1,920
"	Added training checklist	34
"	Added compliance checklists	31-33
"	Added duct labelling requirement	12
"	Removed safety cabinet selection checklist and replaced with new table	8

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SCOPE

SCOPE

1. The microbiological safety cabinet (MSC) is an essential tool in many microbiological laboratories. If appropriately selected and installed, well used and properly maintained they can provide a level of protection to the user from exposure to hazardous aerosols and/ or a sterile environment to work in.
2. This Code of Practice (CoP) describes College standards for the selection, installation, use, maintenance and decommissioning of MSCs. It is aimed at College research staff and students working with, or controlling work with, hazardous biological material, Safety Officers, Building Project Managers as well as College contractors and consultants.
3. Users should contact their Safety Officer or the College BioSafety Team immediately for advice should existing MSCs used for hazardous work fall short of the requirements of this CoP.
4. Note that this CoP does not cover, nor apply to, work at Containment Level 4.

POLICY AND COMPLIANCE

POLICY AND COMPLIANCE

Policy, Legislation, Guidance and National or European Standards

5. This CoP is implemented under the College's Health and Safety Policy on Local Exhaust Ventilation (LEV) and provides the detail necessary to help College users to comply with this policy.
6. Adherence to all aspects of this CoP is mandatory when the MSC is required to control exposure to, or release of, biological agents in Hazard Group 2 or 3 and Genetically Modified Organisms (GMOs) in Class 2 or 3.
7. The responsibilities of all relevant parties in achieving such compliance is described within this CoP. The compliance checklists provided within Appendix H and Appendix I should be used by the research departments and FM, respectively, as a tool to asses levels of compliance.
8. When used solely for the protection of the work then compliance with this CoP is encouraged only on the grounds of best practice. However, any cabinet which does not comply with this CoP must be clearly labelled as such and it remains the responsibility of the Principal Investigator to ensure that the equipment is never used for hazardous work. Furthermore, the responsibilities held by Facilities Management for cabinet ductwork and plant located outside of the laboratory space remains the same for all MSCs.
9. BS EN 12469 provides the performance criteria to which new MSCs should conform. However, it is essential that the UK National Foreword for this standard is also read as this makes particular note of the fact that the Control of Substances Hazardous to Health (COSHH) Regulations places additional requirements for performance monitoring of MSCs over those described in BS EN 12469. For example, BS EN 12469 does not require routine operator protection factor testing (but thorough examination and testing of local exhaust ventilation is a particular requirement under COSHH). The ramifications for this lack of a mandatory requirement for routine testing are, in part, that a BS EN 12469 compliant cabinet may not be easily fumigable. This may have consequences on the use of certain cabinets for work presenting a risk of infection to the user or engineer.
10. As BS EN 12469 does not cover installation or commissioning of MSCs, the British Standard BS 5726:2005 must be referenced.
11. The Advisory Committee on Dangerous Pathogens (ACDP) publication 'Management, Design and Operation of Microbiological Containment Laboratories' details the UK requirements on the use and performance testing of MSCs. This document is used as guidance by the Health and Safety Executive inspectors and adherence to the standards set in this guidance will ensure compliance with legislative requirements.
12. The Advisory Committee on Genetic Modification (ACGM) 'Compendium of Guidance' provides further details on risk assessment and the selection and use of control measures, including MSCs when working with genetically modified micro-organisms.
13. The HSE guidance document 'Controlling airborne contaminants at work' (HSG258), whilst not making specific reference to MSCs, does describe clearly all the requisite features of any

POLICY AND COMPLIANCE

local exhaust ventilation system and as such provides a relevant reference.

Requirement for the use of an MSC

14. The legislation covering work involving GM or non-GM agents differs subtly; COSHH requires that at Containment Level 2 and 3, procedures that may give rise to infectious aerosols must be carried out in an MSC or other suitable containment. The Genetically Modified Organisms (Contained Use) Regulations on the other hand require that at Containment Level 2 an MSC must be used simply when a need is identified by the risk assessment. However, all work with Class 3 GMOs must be undertaken in an MSC or equivalent containment.
15. It is a requirement under the College's Health and Safety Policy on work with biological agents and GMOs, that material that is or may be contaminated with biological agents in Hazard Group 2 or 3, or GMOs in Class 2 or 3, is controlled (where elimination is not possible) through the use of engineered control measures. Where this work presents a risk to the worker of airborne or droplet exposure to agents that are infectious via this route then an MSC is usually required. The need for this must be identified within the activity risk assessment.
16. The requirements for the use of an MSC for operator protection are summarised in **Table 1**.

TABLE 1 REQUIREMENT FOR THE USE OF AN MSC FOR OPERATOR PROTECTION

Work type	Class 2/Hazard Group 2	Class 3/Hazard Group 3
GM	When the need is identified by risk assessment[1]	All work unless contained by other equivalent measures
non-GM	When the need is identified by risk assessment[1]	When the need is identified by risk assessment[1]

[1]Factors to consider in this risk assessment are;

- is the material infectious by aerosol or droplet?
- does the procedure involve the generation of aerosols or droplets?
- can such droplets or aerosols be generated accidentally in the event of spillage?

RESPONSIBILITIES

RESPONSIBILITIES

17. The responsibilities for the various components of the CoP rest with either the research department, Facilities Management, Building Projects or the Safety Department. These duties are summarised in this section but are also referred to elsewhere within the CoP.

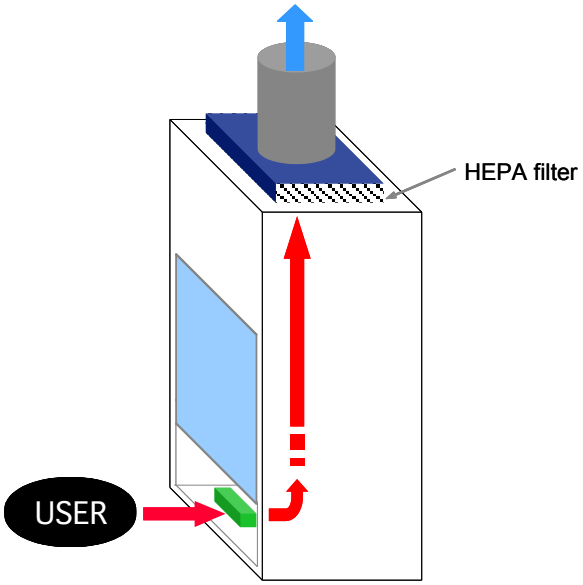
Safe use

18. In line with the College's Safety Management System, responsibility for the activities conducted within MSCs rests with the research department head, the Principal Investigator and the user.

Selection, installation and commissioning

19. Correct selection of the MSC will be through risk assessment and by understanding the nature of the risks associated with the work. As such, the Principal Investigator must have completed such risk assessment and have obtained approval for such work through their local safety officer and the Safety Department (as required within College Policy).
20. MSCs are paid for by the research group or their department unless provided as part of a capital project. The same usually includes for the associated extract ductwork and plant.
21. All MSCs must be installed by a competent engineer. Only recirculating MSCs can be installed via an arrangement direct between the research department and the supplier. All ducted cabinets must be installed either by Building Projects or by the Building/Campus Manager. It is the responsibility of therefore either the research department or Facilities Management/Building Projects for the installation and commissioning, depending on who is in control of the order.

FIGURE 1



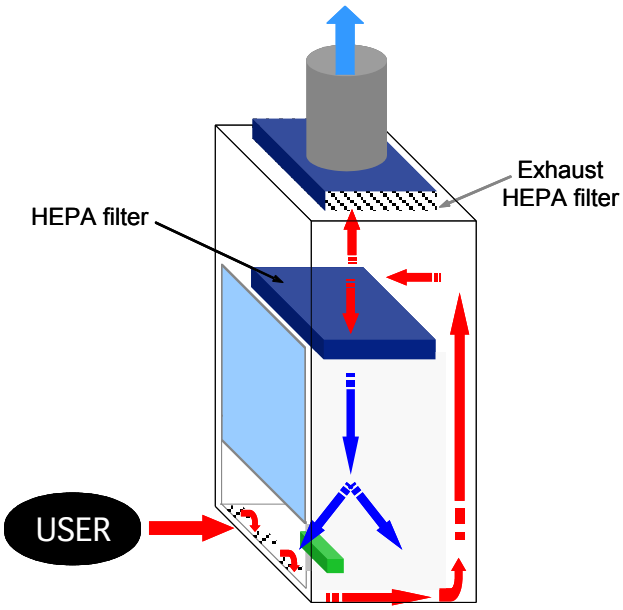
CLASS I SAFETY CABINET

OPERATOR PROTECTION

Air is drawn from the laboratory past the user, through the aperture over the sample (shown in green) and the work surface and via at least one HEPA filter to exhaust.

Can be used to handle biological agents in Hazard Group 1 – 3 and Genetically Modified Organisms in Class 1 – 3.

FIGURE 2



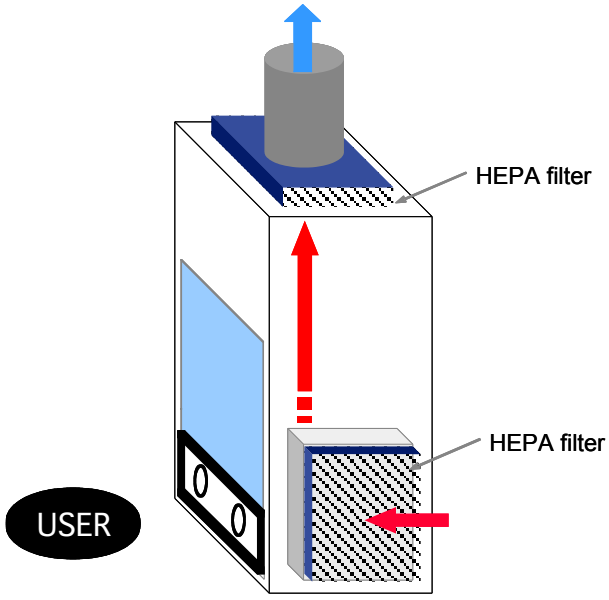
CLASS II SAFETY CABINET

SAMPLE AND OPERATOR PROTECTION

Air is drawn from the laboratory past the user, through the aperture, down a perforated grille away from the sample through a plenum usually located at the rear of the cabinet. A fan then pushes a proportion of this air (usually 70%) through a HEPA filter into the cabinet work area and over the sample. The other 30% air is extracted from the cabinet, via at least one exhaust HEPA filter. All air from the cabinet interior is then re-entrained through the work surface apertures into the plenum and either filtered for recirculation or exhaust.

Can be used to handle biological agents in Hazard Group 1 – 3 and Genetically Modified Organisms in Class 1 – 3.

FIGURE 3



CLASS III SAFETY CABINET

ENHANCED SAMPLE AND OPERATOR PROTECTION

The work area is completely enclosed and the user handles their sample through glove ports. The interior of the cabinet is maintained at a significant negative pressure and all air is drawn in via a HEPA filter and then extracted to atmosphere via at least one HEPA filter.

These can be used to handle any biological agent or genetically modified organism (including those in Hazard Group 4 or Class 4).

RESPONSIBILITIES

TABLE 2 SELECTION CRITERIA FOR DUCTED OR RECIRCULATING MSCS

Work type	Ducted cabinet	Recirculating cabinet
All CL3 work	Yes	Yes if safe fumigation available and if exhaust is double HEPA filtered
All Hazard Group 2 or Class 2 cultures plus unscreened tissues or tissue cultures	Yes	Yes if safe fumigation available and if exhaust is double HEPA filtered
Work with radioisotopes	Restricted use	Restricted use
Work with hazardous chemicals	Restricted use	Prohibited (with the exception of fumigants if safe systems are in place)

Cleaning and decontamination

22. In all cases, the research department is responsible for ensuring that the MSC and any associated ductwork or equipment is in a safe condition before any contractor or other person is permitted to work on the cabinet or equipment.

Maintenance

23. The responsibilities for the maintenance and testing of safety cabinets and their associated extract plant are divided between Facilities Management and the research department that owns the safety cabinet.
24. Responsibilities are summarised as follows (as agreed within the SLA between Facilities Management and College Faculties);
    - Recirculating MSCs are entirely the responsibility of the research department
    - For ducted cabinets, the research department is responsible for all maintenance and performance testing of the cabinet itself, including any filters located within the cabinet. The department is also responsible for the maintenance and testing of any extract plant associated with the cabinet when that plant is located within their laboratory. For ductwork or extract controls and fans outside of the laboratory space (including ceiling voids) Facilities Management are responsible for investigations should the cabinet engineer identify a potential issue during their cabinet performance testing. Research departments must ensure that they involve Facilities Management in this process.
    - For those laboratories in which the extract air is High Efficiency Particulate Absorbance (HEPA)-filtered separately from the cabinet extract system, Facilities Management are responsible for filter testing and replacement. For Containment Level 3 laboratories, testing must take place every 6 months and be arranged in accordance with the suite procedures.
    - Facilities management is responsible for the maintenance of the plant that supplies air to laboratory space.
25. In all cases, those responsible for maintenance and testing must make the necessary arrangements to ensure that this is carried out by a competent engineer and that records of these tests are retained.

SELECTION

SELECTION

Types of cabinets

26. All classes of MSC can, if used correctly, provide a good level of protection to the user whilst handling biologically hazardous samples. Class II and III cabinets can also provide a good level of microbiological protection to the work by ensuring that HEPA-filtered air passes over the sample. The key features of the three types of MSC are summarised in Figures 1 - 3.
27. The class of MSC to be used will be identified by risk assessment. The key points to consider when performing this risk assessment are;
    - the properties of the micro-organisms in use including their route of transmission, infectivity, survival in environment, and susceptibility to disinfectants
    - the nature of the work, particularly the scale and whether aerosols could be generated
    - the need for maintaining a sterile airflow over the sample

TABLE 3 SUMMARY OF MINIMUM STANDARDS FOR MSCS

Compliance required with:	Known or suspected Hazard Group 2 or 3 biological agents or Class 2 or GMOs	Tissue/cell culture (sample protection only)	Human or animal tissue or cell culture (sample and user protection)	Animal/plant pathogens
BS EN 12469	Mandatory	Advisory	Mandatory	Advisory
BS 5726:2005	Mandatory	Advisory	Mandatory	Advisory

- whether other substances such as radioisotopes or volatile hazardous chemicals will also be used

28. A few manufacturers offer special versions of these three classes of cabinet. They can range from Class I or Class II cabinets modified with a larger aperture, so as to allow equipment to be passed into the workspace, to hybrids between Class I or III type cabinets. If purchasing a non-standard cabinet it is essential that the cabinet still retains full compliance with all the relevant standards.
29. Laminar Flow cabinets must not be confused with MSCs as the former blow air out from the cabinet interior into the room. It is therefore not possible to use hazardous material with Laminar Flow cabinets. However, even when using non-hazardous material users should reconsider acquiring a Laminar Flow cabinets as Class II MSCs can usually afford the same level of protection to the work as these. The exception to this would be if the work is non-hazardous and requires a sterile environment but the size and nature of the equipment required within the cabinet would preclude a Class II from affording the necessary level of protection.
30. Cage changing stations, unless certified to BS EN12469, are not MSCs and must not be used for the containment of biological agents in Hazard Group 2 or 3, or genetically-modified organisms in Class 2 or 3. Cage changing stations can however be used for the control of exposure to laboratory animal allergens if tested monthly for airflow performance by the users and by a competent engineer at least annually.

Recirculation of exhaust air to the laboratory

31. All air exhausted from an MSC must be passed through an H14 grade HEPA filter (see paragraph 38). Whilst it is best practice to exhaust this air direct to the outside atmosphere, it is sometimes necessary to consider recirculation of this back into the laboratory. The College's standards for the selection of MSCs and when recirculation of exhaust air may be considered are outlined in **Table 2**.
32. Recirculating cabinets used for work involving known or suspected Hazard Group 2 or Class 2, or higher, agents must be fitted with a double HEPA filter on the exhaust. These filters must be installed so as to be able to be tested independently of each other.
33. HEPA filters offer little or no protection against chemical vapour therefore all work in recirculating MSCs must be carefully controlled so as to ensure that hazardous substances are not released back into the laboratory space. All recirculating MSCs should be clearly labelled as such. The signage depicted in Appendix B can be used for this. Copies are available from the Safety Department, Campus Safety Managers, Faculty Safety Managers, DSOs and Campus/ Building Managers.

Suppliers

34. MSCs are supplied either direct by the manufacturers or via agents. The quality and performance of the cabinets and backup service available varies considerably even within the boundaries of the minimum standards laid out in **Table 3**. For this reason, and because there are a number of installation and commissioning considerations, your local Safety Officer must be consulted before purchasing any safety cabinet.
35. The Safety Department BioSafety Team must also approve the selection of all safety cabinets to be installed within Containment Level 3 laboratories.
36. When selecting a cabinet and supplier the following points should be considered;

SELECTION

- Safety cabinets cannot be considered as 'out of the box' items. Each require appropriate selection, under the advice of a competent manufacturer. Once delivered they must then be appropriately sited, commissioned and training provided prior to their use. Establish that your supplier can deliver all this.
- Always buy the best cabinet you can afford. Budget savings should be sought elsewhere other than with control measures.
- If purchasing through an agent, careful checks must be made on the relationship between the agent and the cabinet manufacturer. Purchasers should be aware that agents change the cabinets they sell and support.
- If purchasing through an agent, check what access there is to technical support from the manufacturer both for the users and for the installation contractors.
- It may be advisable to obtain a quote direct from the manufacturer – but ensure that like is compared with like.
- Check the service and maintenance backup provision. This is especially pertinent when purchasing MSCs made abroad but sold by agents in the UK. It is not unusual for cabinet manufacturers to have no engineers based in the UK.

Electrical safety

37. Purchasers and users must be aware that MSCs manufactured in other parts of Europe in compliance with BS EN 12469 may be wired in a manner that could jeopardise the electrical safety of the equipment[1]. Preference should therefore be given to cabinets wired to comply with the UK standards i.e. with a fuse only on the live conductor.

HEPA filtration

38. It is a requirement within BS EN 12469 that the minimum grading of filtration in MSCs is equivalent to H14 as defined within BS EN 1822.

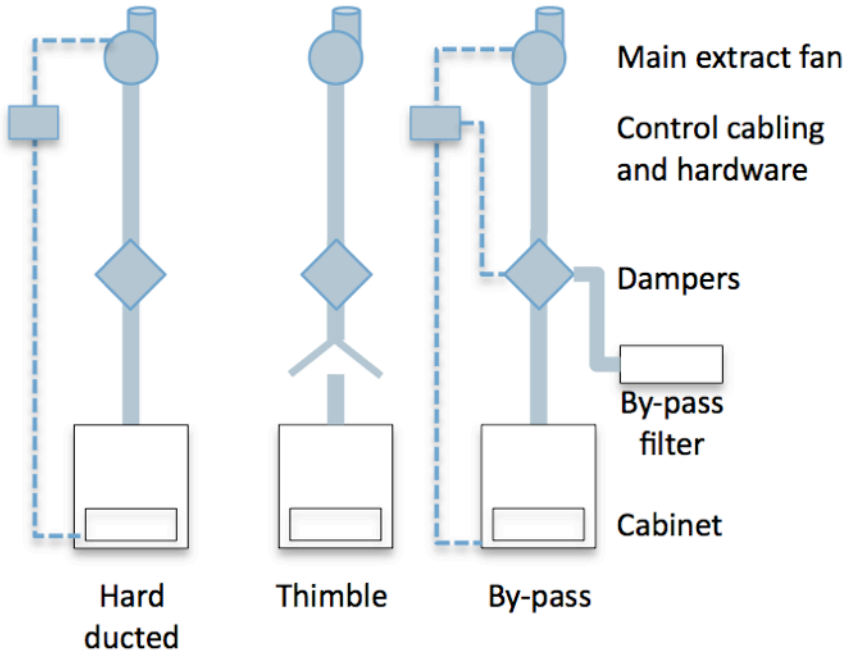
ENERGY SAVING

ENERGY SAVING

39. Safety Cabinets contribute to the College's energy costs and CO_2 output in three ways;
    - through electrical consumption to power the cabinet fans, lighting and any other equipment plugged into the interior sockets. The power loading of a 1.2m MSC will range from less than 0.2kW to 1kW depending on the age and efficiency of the unit.
    - by adding to the heat load within a space.
    - ducted MSCs will rapidly remove heated or cooled air from the laboratory.
40. There are a number of ways in which energy savings can be made;
    - by carefully assessing the number of MSCs required. Sufficient should be provided so as to accommodate the research safely but the number installed should be controlled.
    - selecting the smallest cabinet that will accommodate the work, again without compromising safety. The energy use by a safety cabinet is almost directly proportional to its width.
    - assessing whether or not recirculating MSCs can be used. The selection criteria in **Table 2** must be included in this assessment.
    - obtaining power loading requirements on all cabinets being considered and ensuring that this information is given sufficient weighting in the selection process.
    - once installed, safety cabinets must be switched off when not in use. This will not only reduce energy consumption but will also extend the life expectancy of the cabinet filters.
    - if energy saving features are included in the facility Heating, Ventilation and Air Conditioning (HVAC) design then the impact that these may have on the safe use of the cabinets must be considered. This applies equally to the cabinet extract and to the air supply system as changes in either can affect the performance of a cabinet.
    - it is possible that natural ventilation is considered for lower risk laboratories. This may be appropriate as long as the source of the ventilation (e.g. window) is positioned so as not to cause disruption to the cabinet performance and that all concerns over air temperature and quality are addressed. The Safety Department must be consulted when considering the use of natural ventilation in new laboratories.

[1] mainline Europe requires the installation of fuses on both the live and neutral conductors. This is a contradiction to the requirements in the UK under BS 7671 which prohibits the installation of a fuse on anything other than the live conductor.

FIGURE 4



SAFETY CABINET EXTRACT SYSTEMS

BASIC CONCEPTS

This schematic shows how safety cabinets can be installed in 3 different configurations. Note that this is a simplified outline for illustrative purposes only.

1. **Hard ducted** extract systems direct to a fan either on the roof or out of a window. The duct is solid from cabinet to fan and requires volume control dampers in the ductwork so as to control the air taken from the cabinet. These dampers must be the mechanical constant volume type and under no circumstances be those that vary the air volume (eg VAV dampers).
2. **Thimble** extract systems differ from hard ducted systems in that the air from the cabinet is blown into an open capture thimble from which a volume of air is extracted by the main extract fan. This system must be balanced so as to ensure that more air is extracted via the thimble, than the cabinet exhausts. This ensures that the net flow of air is from the lab into the thimble, and not the reverse. As with hard-ducted systems this control must be achieved using fixed volume control dampers.
3. **By-pass** extract systems draw additional air from the laboratory via a by-pass which can be fitted with a HEPA filter when required. These systems will require controls in order to determine whether the air is drawn from the cabinet or from the by-pass.

INSTALLATION

INSTALLATION

Siting

41. To ensure optimal cabinet performance, MSCs must be correctly sited. If poorly positioned, air currents within the laboratory can disrupt operator and sample protection. BS 5726:2005 provides recommendations for the installation of MSCs in laboratory areas and these are summarised in Appendix A. Note that the College requires these recommendations to be complied with in full.

Power supply

42. In the event of a power failure (or surge) most safety cabinets will trip to OFF and the cabinet will not automatically restart, even once the power supply is restored. The risk of a sustained cut in the electrical supply in London is very low whilst power surges and brief power outages are becoming increasingly common. In order therefore to prevent an unexpected shut down of the cabinet occurring (and thus loss of containment) whilst higher risk infectious material is being handled, all new safety cabinet installations in CL3 laboratories must include backup from an Uninterruptible Power Supply (UPS). These UPS must be capable of providing the cabinet(s) with at least 5 minutes backup and generator backup, if required, must only be in addition to UPS.

FIGURE 5

EXTRACT SYSTEM DESIGN INSPECTION

The complex layering of the ductwork shown in the top photo makes thorough inspection of all the ductwork difficult.

The lower photo shows the extent of the damage to one of these ducts. The added difficulty of checking those ducts deeper within this clump hid the fact that other ducts were also damaged and thereby adversely affecting the performance of the cabinets to which they were connected.

Cabinet extract system

43. BS 5726:2005 must be adhered to when designing and installing the extract ductwork and fans and the general principles described with the HSE guidance note HSG 258 'Controlling airborne contaminants at work' followed.
44. The different concepts in safety cabinet ducted extracts are illustrated in **Figure 4**.
45. All ducted cabinets must be installed either as part of a Building Projects-managed project or, with the involvement of the Campus/ Building Manager.
46. Although the exhaust air from MSCs can generally be considered as free of microbiological contamination because of the HEPA filtration, most cabinets will require periodic fumigation and this will liberate substantial quantities of hazardous chemicals, usually formaldehyde vapour, during aeration of the cabinet. Duct exhausts must therefore be sited with due consideration of the surroundings. As a rule, MSC exhaust ducts must not be within 3 m of any opening windows, air intake grilles or in any other position that needs to be accessed by maintenance staff or contractors.
47. In general duct terminals must be designed so as to create the maximum exit velocity so as to clear the surrounding area. This usually means that devices such as 'chinese hats' or T pieces should be avoided and the duct should either be terminated with a plain duct ending or one tapered to accelerate the velocities. There are exceptions to this principle and times when a protective device over the duct terminal is advisable; for example, ducts ending horizontally in very tall buildings can be susceptible to wind perturbance and as such should be protected with a suitable device.
48. Duct systems must be designed, so far as possible, so as to allow thorough visual inspection. An example of a poorly laid out duct 'complex' is shown in **Figure 5** - the picture therein also demonstrating why it is so important to be able to inspect your ductwork.
49. New extract ductwork and safety cabinets installed after January 2011 must be clearly labelled so as to enable contract engineers and maintenance staff to be able to identify which duct serves which cabinet. The labels must be positioned at each maintenance access point

e.g. access hatch or riser door and the labels must contain information on;

- the fan asset number
- the room number in which the safety cabinet is located
- the serial number of the cabinet

50. Facilities Management together with the Safety Department will undertake a rolling program of identification and labelling of existing ductwork.

Air supply and air conditioners

51. A supply of air, usually equal to that extracted by the MSC(s), must be provided in order for the cabinet(s) to perform adequately. When this air is supplied mechanically to the laboratory, steps must be taken to ensure that this supply is adequate, constant and reliable.
52. All make up air, whether or not mechanically supplied, must be delivered in such a way so as to cause the minimum disruption to the MSC airflow pattern. BS 5726:2005 advises that all air velocities, within a laboratory housing safety cabinets, are maintained below 0.3 m/sec. If these velocities are exceeded then the installer and the users must ensure that these higher velocities are situated and directed in such a way that they never perturb cabinet performance.
53. Careful consideration must be given to the siting of MSCs in relation to the laboratory doors and windows as these, when opened and closed, can cause significant disruption to the cabinet airflow patterns.

Control strategies

54. The best MSC installations have the simplest control strategies. For thimble ducted cabinets this can be as simple as a complete lack of control or interface between the cabinet and the main fan (with some sort of indicator that tells the user that the main extract fan is working properly). For hard ducted and by-pass ducted installations more control is, by necessity, required but again these can be of uncomplicated design using mechanical air volume control devices and the operation of the main extract fan overseen by a hard wire link between extract fan and cabinet.
55. In all cases, the MSC, dampers or main extract fan must not be controlled by networked BMS. It may however be advisable under certain circumstances (e.g. at CL3) to utilise the BMS to monitor the operation of the main extract fan.
56. Variable air flow control dampers and devices are not appropriate for use on MSC extract systems as these can often interfere with the operation of the cabinet, especially at start up and shut down.
57. The BMS should also ideally not be used for controlling the air supply into a Containment Level 2 or higher space in which safety cabinets are located. Safety cabinet alarms must not be connected to the BMS.

Recirculation of cabinet exhaust air into laboratory space

58. Recirculating cabinets must be installed with adequate space between the exhaust point and any obstruction (usually the ceiling) so as to prevent any disruption of the exhaust flows themselves (back pressure can affect cabinet performance) or of the cabinet airflow patterns at the aperture caused by high velocity exhaust air bouncing off obstructions in the laboratory.

Competence of installers

59. The installation of an MSC must be carried out by a competent engineer. If Departments or users arrange directly with suppliers or their agents, and the installation is not directed by Building Projects or Building/Campus Managers, then it is their responsibility to ensure the competence of the installer.
60. Building Projects or Building/Campus Managers must employ competent and experienced staff or contractors to install cabinets.
61. The Safety Department can be contacted at any stage in order to discuss recommended Safety Cabinet installers and commissioning engineers.

Commissioning

62. During commissioning and routine testing, all aspects of the laboratory ventilation must be in operation. If necessary, doors must be opened and closed to establish if this perturbs the cabinet's performance. Equipment that may affect the performance of the safety cabinet must in place, and if necessary, switched on.
63. All commissioning tests specified in BS EN12469 must be completed. This must include an operator protection factor test (OPFT) or an in-use OPFT as necessary (see paragraph 105). A record of these tests must be passed on to the users (or their manager) before use of the cabinet.

Information at handover

64. Before first use of an MSC it is essential that the operators know that it has been successfully commissioned and that use must be prevented should commissioning have identified a failure in performance.
65. The cabinet owner, or their designate e.g. Lab Manager, must be issued with the following information at handover;
    - a complete commissioning certificate. This certificate must indicate clearly the test conditions and the results of these tests
    - the manufacturer's instruction manual
66. In addition, each cabinet must be clearly labelled with a summary of the commissioning test results. This should provide all the information described in **Figure 6**.
67. Should the cabinet not pass its commissioning tests in full, then this result must be communicated clearly to the cabinet owner and its use prevented until such time that repairs are completed.

USE

Written instructions

68. A well installed and maintained safety cabinet will only protect the researcher or their sample if the cabinet is used properly. Clear instructions (usually in the form of Standard Operating Procedures – SOPs) on the correct use of an MSC must be supplied with new equipment and this information must be disseminated to all users. It will be necessary to develop and record these SOPs where they are not currently available for existing cabinets.
69. The instructions must provide information on;
    - Any designation of a particular cabinet for particular work, including any restrictions on its use
    - The operation of the MSC (see Appendix D for example SOP)
    - How to work safely and effectively at the cabinet
    - How to decontaminate after use – topical disinfection and fumigation
    - How to monitor the performance of the cabinet (e.g. monthly airflow test – see Appendix F and Appendix G for SOP and record templates)
    - What action to take if an alarm sounds or if any other problem is suspected

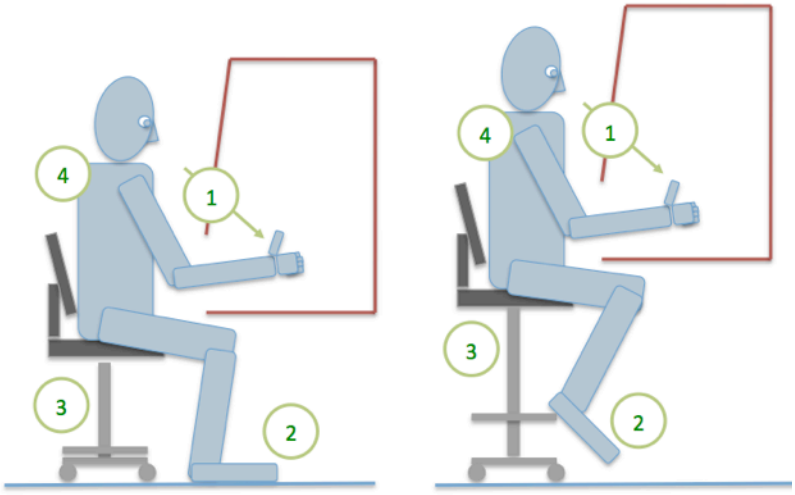
Training

70. No person should be allowed to work at an MSC unless proper training has been given and the person is competent to do the work. Such training must be recorded and should include instruction on at least all the items listed in Appendix J. The ability of the user to operate the MSC and to conduct their work safely within the cabinet must be assessed prior to their being allowed to work unsupervised. Again the checklist provided in Appendix J can be used for this purpose.

User influences on cabinet performance

71. The following practices can cause disruption of the airflow patterns and hence, the performance, of a safety cabinet
    - Rapid movements of arms in and out of the front aperture – movements must be slow and as infrequent as possible
    - Placement of large equipment such as microfuges and vortexes within cabinet interiors –

FIGURE 6



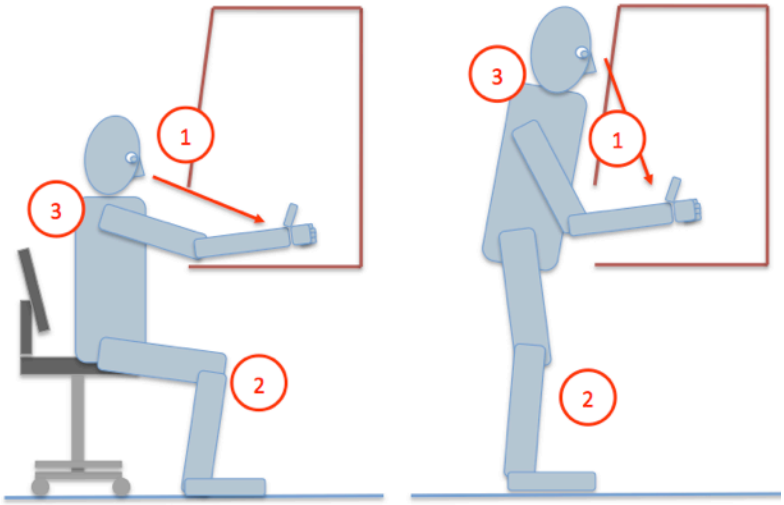
ERGONOMICS

SITTING COMFORTABLY

The two users shown here have adjusted their chairs so that even though the two cabinets differ greatly in height off the ground, they are sitting comfortably and in a position that makes best use of the cabinets safety features;

1. good vision of the work area with the maximum protection afforded to the face, eyes and breathing zone in the event of a release or spillage inside the cabinet
2. feet supported either on the ground or on the foot rest
3. chair adjusted to best effect
4. back and shoulders under the least possible strain

FIGURE 7



ERGONOMICS

POOR USE

The user on the left has not adjusted their chair properly and is sitting much lower than they should. The user on the right has decided to stand. Neither are comfortable nor are either using the cabinet in the safest manner possible;

1. the user on the left has left their face and eyes potentially exposed in the event of a spillage or release within the cabinet. Similarly should an aerosol escape from the cabinet their breathing zone is now very close to the cabinet aperture
2. and 3. by adopting these positions they will be uncomfortable and will tire more quickly and if the work is prolonged could lead to, or exacerbate, musculo-skeletal injuries

USE

these should be placed as far to the back of the cabinets as is possible and the cabinet performance tests must be carried out with the equipment in place

- Obstruction of air grilles – equipment and consumables must never block any of the grilles
- Gas burners – flames can perturb the airflow patterns, and hence performance, of a cabinet, as well as cause damage to the MSC or its filters. Therefore the use of burners in MSCs is prohibited.

Ergonomics

72. MSC users must understand not only how to use a cabinet safely and how the cabinet operates but must also be trained on how to use the cabinet comfortably and to position themselves in a manner that allows them the maximum possible comfort and protection.
73. Most cabinets are installed with a work surface height of approximately 900mm and very few are fitted with height adjustment capability. In order to achieve the most comfortable working

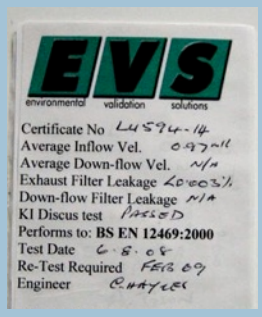
height at a cabinet it is almost always necessary for the operator to be able to adjust their chair. Principle Investigators must ensure that good quality height adjustable chairs with non-absorbent wipe-clean surfaces are provided. Users must ensure they make proper use of these facilities and adjust the chair to the best position for them before use.

74. **Figures 6** and **7** outline some of the key issues to consider when arranging your working position at a cabinet.

FIGURE 8
ENGINEER INSPECTIONS
LABELS

All safety cabinets used for hazardous procedures must be marked with a label that clearly states

1. that the cabinet passed or failed its latest test (if failed this must be supplemented by further action)
2. that the cabinet was last tested within the requisite period
3. a summary of the airflow velocities, filter integrity tests, duct pressure tests and operator protection test where carried out.



75. Advice on ergonomic comfort at the MSC is available in the first instance from your local Safety Officer.

Labelling and marking

76. All cabinets must be labelled and marked clearly so that the information relevant to the use of that particular MSC is obvious. The following signs and labels must be displayed on the cabinet, as relevant;
    - Biohazard symbol plus any other hazard symbol if relevant
    - If ionising radiation is to be used then a trefoil is required along with details on the radioisotope(s) being used and the nature of the radiological hazard (e.g. H-3, unsealed radioactive material)
    - Classification of cabinet
    - Any restrictions on its use e.g. a recirculating cabinet must not be used for volatile high hazard chemicals such as carcinogens or toxics
    - Warning label to externally isolate cabinet before gaining access to carry out electrical work or inspections
    - The last date of inspection by an engineer which includes a summary of the test results (see **Figure 8**)
    - The risk assessment for its decontamination
    - The records of the monthly airflow checks, where required
77. The signage shown in Appendix B can be used to label cabinets. Sticker versions of these are available from the Safety Department.
78. All ductwork serving safety cabinets and that is located outside of the laboratory space must be clearly labeled as described within paragraphs 49 and 50.

Use of hazardous chemicals

79. Safety cabinets are not fume cupboards. The use therefore of volatile hazardous chemicals and solvents in a hard-ducted MSC must be restricted to their small scale use for experimental work with biological agents. The use of hazardous chemicals in an MSC must always be subject to risk assessment and recirculating cabinets must never be used for such work.

Use of radioisotopes

80. The use of radioisotopes in MSCs raises some particular issues over and above those encountered with biological agents;
    - as all air extracted from MSCs must pass through a HEPA filter, radioisotope use in cabinets can lead to the entrapment and concentration of isotopes within these filters, especially when bound to cells or proteins

TABLE 4 PROPERTIES OF FORMALDEHYDE	
Harmful properties	Exposure to formaldehyde causes irritation of skin, eyes, and mucous membranes. It may cause sensitization in some individuals and can cause nasopharyngeal cancer. Formaldehyde has a Maximum Exposure Limit (MEL) of 2 ppm (or 2.5 mg/mL) under the COSHH Regs. It is therefore mandatory to ensure that the exposure to formaldehyde is kept below this limit and indeed as low as practicable.
Physical properties	Vapour is explosive at 7.75% (v/v) in dry air and its ignition point is 430C. It should always therefore be used in humid conditions.
Chemical incompatibilities	Formaldehyde can react with chlorine-containing compounds (HCl and NaOCl) to form bis(chloromethyl) ether, a known lung carcinogen. All chlorine containing compounds, such as Chloros, must therefore be kept in sealed containers if they could be exposed to formaldehyde during the fumigation.

- Volatile small molecular weight components are not trapped within HEPA filters and will therefore be re-entrained into the laboratory from recirculating MSCs.
- MSCs are fitted with many features designed to improve the airflow patterns. These do however involve the use of plenums, grilles and internal fans, all of which are very difficult, or impossible to access for cleaning. Microbiologically these are not an issue as the they can be rendered safe by disinfection. When radioisotopes are used however, access and decontamination of these areas cannot be achieved.
- MSCs cannot easily be fitted with additional shielding.

81. The use of radioisotopes must therefore always be subject to separate risk assessment from that carried out for the work involving biological agents and in all cases is subject to radiation work registration. It should be noted that work with radioisotopes in MSCs will always be limited and users must recognise that, as explained in the previous paragraph, MSCs are not designed for work with radioactivity. As a rule only cell uptake or labelling experiments involving 14-C, 3-H or 35-S will be approved to take place within MSCs. Note that the requirement will be to carry out any steps that may result in volatile radioactivity within a fume cupboard, and only those involving the tissue culture procedures would be allowed in an MSC.
82. During the radiation work registration process the following restrictions will be imposed before approval is granted;
    - the cabinet and the HEPA filters must be labeled with the radiation trefoil.
    - a safe means of removal of the HEPA filters will need to be identified.
    - the appropriate route of disposal of the HEPA filters must also be identified.
    - routine and emergency clean up and decontamination protocols will need to be established.
83. In order to ensure that biological and radiological work methods are complementary, it is important that the Principle Investigator describes fully the work methods they will employ in a radiation work registration. This will include use, cleaning, decontamination and waste disposal. With this information the College RPO / RPA can ensure that the methods described in this CoP do not give rise to radiation exposure for specific pieces of research. It is recommended that the radiation protection manual is consulted for further information which can be found online.

CLEANING AND DECONTAMINATION

Cleaning

84. It is essential that MSCs are kept clean. All spillages of infected material or of uninfected media, buffer or other liquids must be cleaned up as soon as possible. Particular care must be taken with Class II cabinets where checks under the perforated work surface should be made after every use. All significant spillages of infected material must be fumigated before wiping up the spill with disinfectant.
85. It is advisable to wipe down cabinets with soap and water following application of chemical disinfectant. This will remove residues that may adversely affect your work and protect the

metallic surfaces of the cabinet from any corrosive properties of the disinfectant in use.

Disinfection

86. The nature of the work undertaken in these cabinets necessitates that for both unplanned spillage situations and for planned maintenance and testing appropriate disinfection procedures of the cabinet be developed. These will range from the use of topical chemical disinfectants, either wiped or sprayed, to the gassing of the cabinet with formaldehyde.
87. Most chemical disinfectants are hazardous to human health but formaldehyde, in particular, poses a significant risk due not only to its properties (see **Table 4**) but also the manner in which it is used. It is therefore essential that the need to use this substance is carefully risk assessed, that a detailed SOP for the disinfection of the MSC is developed and that this incorporates the findings of the assessment. An example of such an SOP is provided in Appendix F.
88. All MSCs in CL3 laboratories must be fumigated prior to any engineer inspection or work.
89. MSCs in CL2 laboratories need not necessarily be fumigated prior to being subjected to routine testing or servicing as laid out in **Table 5** (CL2 column). Cabinets will however in all cases have to be effectively cleaned and topically decontaminated prior to issue of the Permit-to-Work.
90. MSCs used for handling Hazard Group 2 biological agents, Class 2 GMOs or unscreened human tissues must usually be fumigated in the following circumstances;
    - Before any maintenance work on the cabinet where access to potentially contaminated parts is necessary
    - Before replacement of the filters
    - After a spillage where inaccessible surfaces may have become contaminated
91. Formaldehyde fumigation of recirculating MSCs is possible through the use of formaldehyde neutralisation systems or charcoal absorption filters. However, it is essential that before fumigation of these cabinets all aspects of the process are considered including;
    - What measures are needed to seal the cabinet. If access to the top of the cabinet is required to close dampers or cover the cabinet in a plastic bag, safe means for doing so must be readily available and working at height risk assessed.
    - Establishment of emergency procedures in the event of fumigant leakage, for example, whether the room can be sealed and whether there is adequate air extraction from the laboratory space.
    - Training. The competence of the person carrying out the fumigation must be established and their training recorded.
92. Contractors may be used to carry out fumigation of MSCs however, it is important to remember that the responsibility for the safety of the process remains with the research department and the College. In all cases competent contractors only must be used and advice on these can be obtained from the Safety Department BioSafety Team.
93. Pro-forma risk assessment MSC1 (see Appendix D) is designed to help you balance the risks of infection to yourself, others in the laboratory and to the service/ test engineer, arising from the work undertaken in a particular MSC, against those associated with formaldehyde fumigation of a particular cabinet. The completed risk assessment should be affixed to the relevant MSC.

Decontamination

94. In addition to disinfection of the cabinet, it may be necessary to consider other possible contaminants, such as radioactive or otherwise hazardous substances. It is essential that the user has identified within their risk assessment the likelihood of such contamination and on how to prevent this occurring in the first place and on how to deal with it should it occur.

MAINTENANCE AND PERFORMANCE TESTING

Routine maintenance

95. Any MSC used at Containment Level 2 or 3 must be serviced according to the regimes specified by the manufacturer. The minimum standards for such maintenance, as detailed in BS EN12469, are summarised in **Table 5**. When used for non-hazardous work, in other

TABLE 5 FREQUENCY AND NATURE OF ROUTINE MAINTENANCE AND PERFORMANCE TESTING

	Containment Level 2	Containment Level 3
Every use (by users)	• Alarms/ indicators	• Alarms/ indicators
Monthly (by users)	• Airflow test (inflow for Class I, inflow and downflow for Class II)*	• Airflow test (inflow for Class I, inflow and downflow for Class II)
6 monthly (by engineer arranged by users)	• Check manufacturer's requirements for maintenance • Visual examination of cabinet surfaces to check for damage • Examination of visible extract ductwork within the laboratory • For ducted cabinets, duct pressure test (using the clean side DOP test point) • Check of anti blow-back device • Checks and recalibration of alarms/ indicators/ pressure gauges • Airflow test	• Check manufacturer's requirements for maintenance • Visual examination of cabinet surfaces to check for damage • Examination of visible extract ductwork (where practicable) • For ducted cabinets, duct pressure test (using the clean side DOP test point) • Check of anti blow-back device • Checks and recalibration of alarms/ indicators/ pressure gauges • Airflow test • In-use KI operator protection factor test (OPFT) • HEPA filter integrity test (including of any by-pass filters)
12 monthly (by engineer arranged by users)	• Check manufacturer's requirements for maintenance • Visual examination of cabinet surfaces to check for damage • Examination of visible extract ductwork within the laboratory • For ducted cabinets, duct pressure test (using the clean side DOP test point) • Check of anti blow-back device • Checks and recalibration of alarms/ indicators/ pressure gauges • Airflow test • OPFT or In-use OPFT (as determined by risk assessment) • HEPA filter integrity test	• Check manufacturer's requirements for maintenance • Visual examination of cabinet surfaces to check for damage • Examination of visible extract ductwork (where practicable) • For ducted cabinets, duct pressure test (using the clean side DOP test point) • Check of anti blow-back device • Checks and recalibration of alarms/ indicators/ pressure gauges • Airflow test • In-use KI operator protection factor test (OPFT) • HEPA filter integrity test (including of any by-pass filters)
* see Table 6		

words, for sample-protection only, it is recommended that the cabinets are well maintained and best practice would ascribe to the maintenance requirements for MSCs at Containment Level 2.

Testing alarms/ indicators

96. These must be calibrated and checked at installation and during the routine 6 monthly and 12 monthly engineer visits. Users should also confirm that all alarms and indicators are operating within their normal parameters before beginning any hazardous work.

Monitoring airflows

97. In addition to the airflow measurements that must be made by an engineer during their 6 monthly and 12 monthly visits, cabinets used for the work listed in **Table 6** must also be

TABLE 6 REQUIREMENT FOR MONTHLY AIRFLOW TESTS

Material handled in the MSC	Must cabinet airflows be tested at least every month?
All work at CL3	Yes
All Hazard Group 2 or Class 2 cultures	Yes, if these agents are potentially infectious via the aerosol route and the work involves the possible generation of aerosols
Unscreened human tissues	Yes, if the work entails generation of aerosols and the material could be contaminated with pathogens infectious via aerosols No, if there is negligible risk of aerosol production or the material is unlikely to be contaminated with pathogens infectious via aerosol transmission
Screened human tissues	No if tissues screened clear of pathogens infectious via aerosol route
Primary tissue cultures	No, if risk of contamination with a human pathogen in Hazard Group 3, or above, is low Yes, if source unscreened and could be infected with human pathogens in Hazard Group 3, or higher, these are potentially infectious via aerosols and the work involves the possible generation of aerosols
Secondary cell cultures	No, as long as the cells have a known history of safe use and the MSC use is for sample protection only
Laboratory animal allergens	Yes

tested on at least a monthly basis by the users.

98. Any cabinet in a Containment Level 2 laboratory that is not subject to the monthly tests must be clearly labelled, in order to prevent the inappropriate use of such a cabinet.
99. Slightly different techniques must be employed for the monthly user airflow tests in Class I and Class II cabinets. Inflow velocities for the former must be measured by the engineer and users using a vane anemometer at the intervals specified in **Table 5**. For Class II cabinets, users and engineers must check both inflow and downflow velocities, again using an anemometer.
100. Records of these monthly measurements must be kept. The example SOPs and record templates provided in Appendix F and Appendix G.
101. Performance testing of Class III cabinets includes two airflow tests. The airflow through each open glove port should be measured (whilst all other ports are closed) and should be at least 0.7 m/sec. The airflow through the inlet HEPA filter should also be tested when the gloves are attached and the cabinet is at a pressure of at least -200 Pa. This should be not less that 0.05m^3/ sec for each cubic metre of cabinet volume. See **Table 7** for full details.
102. The anemometer used for monitoring airflows can be either the vane or hot-wire type. Those selected must be appropriate for use and must be calibrated at least annually for use in both the horizontal and vertical planes according to the manufacturer's instructions. Two examples of suitable anemometers are the LCA301 rotating vane anemometer and the TA410 thermal anemometer, both available from TSI Incorporated (www.tsi.com).
103. Anemometers, as with all other equipment taken into areas in which infectious material is handled, must be effectively decontaminated prior to removal from the laboratory. In most cases, each CL3 suite or laboratory will have its own dedicated machine that is removed only for repairs or calibration.

Visual examination and integrity testing of extract ductwork

104. For ducted safety cabinets, engineers arranged by the research department must include in their routine testing an examination of all visible ductwork and extract plant within the laboratory space. They must also measure and record the duct pressure within the extract duct. This can usually be done using the DOP test point located on the clean side of the extract HEPA filter. This measurement must be recorded on the test certificate and cabinet inspection label so that any significant changes from previous readings can be identified.

TABLE 7 PERFORMANCE OF CABINETS

	Alarms/ Indicators	Anti-blow back device	Inflow	Downflow velocity	OPFT	In use OPFT	Filter integrity
Class I	Function as specified	Function as specified	0.7 – 1.0 m/sec	-	< 1 x 10^5	< 1 x 10^5	< 0.003%
Class II	Function as specified	Function as specified	> 0.4 m/ sec	0.25 - 0.5 m/sec	< 1 x 10^5	< 1 x 10^5	< 0.003%
Class III	Function as specified	Function as specified	>0.7 m/ sec* and 0.05 m^3/ sec**	-	-	-	< 0.003%

* through open glove port, with only one glove removed

** for each cubic metre of cabinet volume through the inlet HEPA filter with cabinet at a negative pressure of at least -200Pa

Operator Protection Factor Testing

105. There are two types of operator protection factor testing. Both use the same equipment to liberate a fixed number of carefully sized droplets of (Potassium iodide) KI into the cabinet interior. The number of particles that escape through the work aperture are then also measured in both cases and expressed as a proportion of the KI released in the cabinet.
106. The first, more straightforward, technique is to conduct this test on the empty cabinet in a working laboratory. The test is as described in Appendix C of BS EN 12469:2000. All aspects of the laboratory ventilation must be operational during the test. This includes air conditioners and other MSCs or fume cupboards.
107. The second, more stringent, test is designed to assess the containment afforded by a cabinet under the conditions of use. This so called 'In-use Operator Protection Factor Test' is a requirement when working with, for example, Hazard Group 3 agents.
108. The key requirement for the 'In-use' test is that the laboratory conditions are as representative as possible of normal working conditions. The basic technique is the same as described in BS EN 12469:2000 but with the following additional criteria.

- The cabinet must be loaded with a typical arrangement of equipment and samples. The 'false arm', as described in BS EN 12469:2000 must also be in place. It is not necessary for a researcher to mimic use of the cabinet during the test as long as this false arm is in place however if any of the equipment to be used within the safety cabinet has its own fan, or is capable of perturbing the airflows, then this must be switched on.
- Significant items of equipment located near the cabinet should be in place and where capable of causing drafts, switched on. This includes such items as centrifuges or any other closely situated equipment fitted with a fan. As with the Operator Protection Factor Test described in paragraph 105, if there are other MSCs or fume cupboards in the laboratory then these must be operating.
- Traffic which could normally occur in the laboratory should be reproduced for the tests.
- There should be no modification of the laboratory or the normal working practices for the purposes of the test.

109. The frequency at which both types of Operator Protection Factor Tests must be carried out is summarised in **Table 5**. These tests must be repeated after any significant changes are made to the lab layout or its ventilation.

Access of engineers

110. All access to contractors and maintenance staff must be carefully controlled. A permit-to-work must be issued before an engineer begins a service. See **Table 8**.

Records

111. It is essential that a record is retained of all services and performance testing of MSCs. The

location of the records must be known to the Principal Investigator. These records may be audited in the course of the local, Divisional and other Safety inspections, or, by an enforcing authority.

Cabinet failures

112. Any failures or near failures identified either in routine use or during monthly, 6 monthly or annual performance tests must be reported to all those that use the particular cabinet. Any such communication must be supplemented with clear signage on the cabinet. Such incidences must also be reported to the Safety Department as a Dangerous Occurrence. Where failures involve the main cabinet extract duct (where one exists), or an issue with the air supply to the laboratory, a defect must also be reported to the FM HelpDesk.

FILTER REMOVAL AND DISPOSAL

Non-radioactive filters

113. Some Class II cabinets are fitted with pre-filters on or behind the grille to the rear of the work surface. This filter must be regularly checked and replaced if obviously dirty or blocked with plastic, paper or other materials. The filter must be decontaminated according to the laboratory protocols before disposal as clinical waste.
114. HEPA filters must be replaced by an engineer as and when users identify via their own airflow tests or indicator dials that the cabinet is not performing correctly or, when the engineer identifies that the filters are blocked as part of their routine tests. A Permit-to-Work must always be issued to the engineer before entry to the laboratory is allowed.
115. Any filter to be taken from an MSC used to contain work with Hazard Group 2, Class 2 or higher biological agents, or, unscreened human tissues or human primary cell cultures must be decontaminated in situ before removal. This is most effectively achieved by fumigation of the cabinet with formaldehyde before removal of the filter. The precise need for, and method of, decontamination of the filter before removal must be subject to risk assessment (see Appendix C).
116. HEPA filters in room extract systems originating from Containment Level 3 laboratories must be disinfected by formaldehyde fumigation and venting of the room itself, where possible. When it is unsafe, or inapplicable to fumigate with formaldehyde, then the filter must be removed and packaged as described in the Local Code of Practice.

TABLE 8 PERMITS-TO-WORK, EQUIPMENT DECONTAMINATION AND AREA CLEARANCE CERTIFICATES

	Which form?	Signed by whom?
Routine maintenance and testing of MSC	Laboratory Permit-to-Work	Lab Manager
Routine maintenance and testing of MSC but investigative works required to ductwork or fans external of the lab	Laboratory Permit-to-Work for access to lab FM Permit-to-Work for access to plant	Lab Manager FM PTW issuer
Works to cabinet ductwork or plant	Laboratory Permit-to-Work for permission to shut down cabinet FM Permit-to-Work for access to plant	Lab Manager FM PTW issuer
MSC decommissioned and removed from active lab for disposal	Permit-to-Work for removal works and Equipment Decontamination Certificate affixed to MSC	Lab Manager
MSC decommissioned and left in vacated lab for disposal	Equipment Decontamination Certificate affixed to MSC and Area Clearance Certificate for laboratory	Lab Manager
MSC decommissioned and removed from active lab for transfer and reinstatement in another lab	Permit-to-Work for removal works and Equipment Decontamination Certificate affixed to MSC	Lab Manager

FILTER REMOVAL AND DISPOSAL

117. Once the HEPA filter has been removed, it must also be bagged by the engineer. For non-radioactive filters, the user must then ensure that the bagged filter is further placed inside a yellow clinical waste bag (or two, as necessary) and that this is taped securely. The following information must then be clearly labelled on the package
    - Contact name and phone number
    - Department/ Section name
    - Description of the contents (i.e. HEPA filter)
118. Contact the Facilities Management Helpdesk on ext 48000 to arrange for disposal. You will be asked to provide the following information:

- Your name
- Your Faculty / Division / Department / Campus
- Name and contact details of your Safety Officer or Safety Manager
- A brief description of the waste (HEPA filter)
- GL code (grant number) for re-charging

119. The Helpdesk will log the information and allocate a unique reference number. This information will be forwarded to the Safety Department who will then contact the named person to arrange for disposal by incineration.
120. MSC filters must not be disposed of via the clinical waste route.

Radioactive HEPA filters

121. If the HEPA filter is known to have been exposed to radioactive materials, the removal, packaging and disposal route identified within the work registration must be complied with. If necessary, the advice of the Safety Department Radiation Safety Team can be obtained. In certain circumstances it will be necessary for additional radiological monitoring to be performed.
122. Before removal of the filters from the MSC, the need for decontamination of any biological agents must be considered.
123. Once removed from the cabinet, the filter must be placed in red bags and the waste then reported to the Safety Department Radiation Team.

DECOMMIS-SIONING

DECOMMISSIONING

124. Effective decontamination is an integral part of the process of decommissioning of an MSC. It is the responsibility of the Principal Investigator to ensure that any cabinet used in the course of their research is made safe before its abandonment (when vacating an area) or, removal of the whole cabinet or part thereof.
125. If the cabinet has, or is suspected of having, been used for radioactivity the Safety Department Radiation Safety Team must be contacted.
126. Once decontaminated, the MSC must be clearly labelled as such either by the use of an Equipment Decontamination Certificate and/or Permit-to-Work. When to use either form is summarised in **Table 8**. More detailed guidance on the use of these forms is given on Spectrum.
127. Any decommissioned MSC can only be disposed of as non-hazardous waste if it is known to have been effectively decontaminated and any hazardous components e.g. electronic components removed.
128. When moving the cabinet for re-use it is worth considering packaging the cabinet so as to protect it from damage in transit.
    - A brief description of the waste (HEPA filter)
    - GL code (grant number) for re-charging
129. The Helpdesk will log the information and allocate a unique reference number. This information will be forwarded to the Safety Department who will then contact the named person to arrange for disposal by incineration.
130. MSC filters must not be disposed of via the clinical waste route.\

MONITORING PERFORMANCE AND COMPLIANCE WITH THIS COP

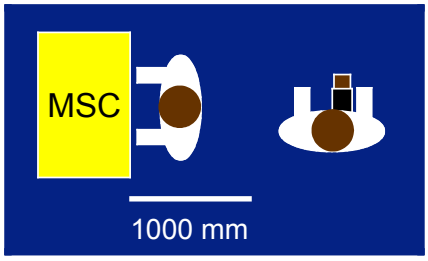
131. it is essential that all those who use, maintain or test, or are responsible for those that use,

MONITORING COMPLIANCE AND PERFORMANCE

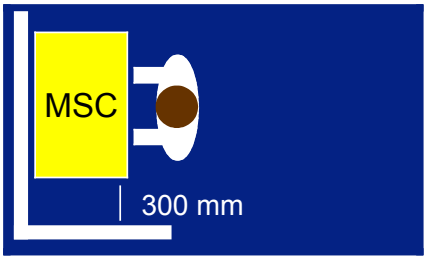
maintain or test fMSCs, must have a clear understanding of the requirements of this CoP.

132. The Safety Department provide training on the key aspects of this to both Academic Departments and to Facilities Management. Academic Departments, and in particular, their Principal Investigators, must ensure that those at risk i.e. those undertaking the work, are explicitly clear as to how to use an MSC safely and in the manner that will best ensure that is performing at its best possible level.
133. The Academic Departments must ensure that the safe use of safety cabinets is monitored appropriately and how often this is done must be established on the basis of risk, with those undertaking the highest risk work being subjected to the closest and most frequent scrutiny.
134. Facilities Management must ensure that their own performance in complying with this CoP is subject to ongoing checks and that these checks are recorded and acted upon where deficiencies are found.
135. The Safety Department will conduct periodic reviews through audit or inspection on both the Academic Departments and Facilities Management.

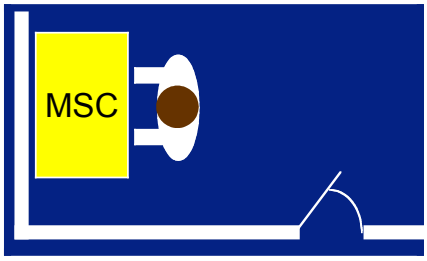
APPENDIX A - LOCATION OF SAFETY CABINETS



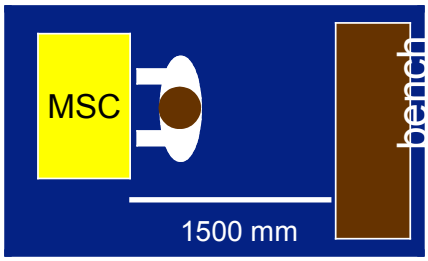
Keep pedestrian traffic away from the front of the MSC



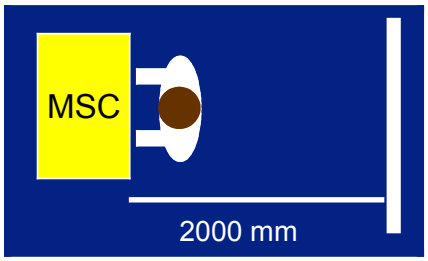
Keep clear of adjacent wall



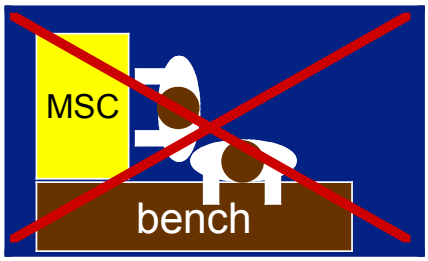
Keep clear of door openings



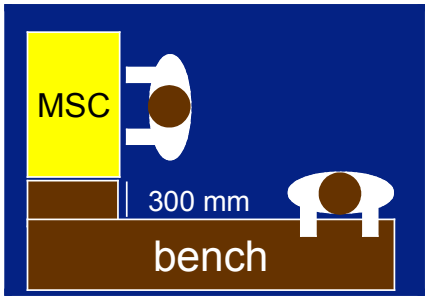
Position clear of bench opposite



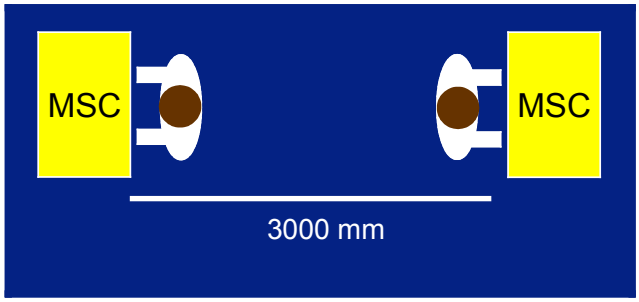
Position well clear of wall opposite



Do not have another worker at an adjacent bench



Allow adequate room for workers at nearby benches



Keep well clear of safety cabinet opposite

APPENDIX B - CABINET FASCIA WARNING SIGNAGE

The appropriate signage must be carefully selected by a competent person. If the nature of the work changes or the cabinet condition alters, then the signage must be updated.

All warning signs are available from the College Safety Department.

1

NOTICE TO USERS AND SERVICE ENGINEERS

THIS SAFETY CABINET IS USED TO HANDLE HAZARDOUS MICROBIOLOGICAL MATERIAL

TO THE USER: This safety cabinet may be used for work posing an infection or allergic risk by aerosol or splashes. Before each use check that:

a) all alarms and indicators indicate that the cabinet is safe for use

b) the airflows have been tested in house within the last month

c) that the cabinet has been tested by an engineer within the last 6 months

TO THE ENGINEER: Do NOT service or validate this safety cabinet unless you have been provided with a Permit- to-Work or Decontamination Certificate

2

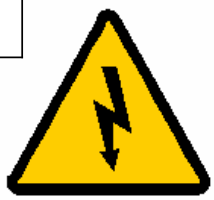
NOTICE TO USERS AND SERVICE ENGINEERS

THIS SAFETY CABINET MUST NOT BE USED TO HANDLE MICROBIOLOGICAL MATERIAL HAZARDOUS THROUGH AEROSOLS OR SPLASHES

TO THE USER: This safety cabinet must only be used for work posing a low risk of airborne infection (including splashes) or allergenicity.

TO THE ENGINEER: Do NOT service or validate this safety cabinet unless you have been provided with a Permit- to-Work or Decontamination Certificate

3



WARNING
This apparatus may be fitted with a fused neutral conductor.
Before entering this cabinet for access to electrical circuits isolate all incoming power supplies externally from equipment.

4

The air from this cabinet is exhausted into the laboratory. The use of volatile hazardous chemicals is prohibited.

APPENDIX C - RISK ASSESSMENT FOR DISINFECTION OF AN MSC

Risk assessment for the disinfection of a microbiological safety cabinet		Date of this risk assessment:
Person responsible for the work in this MSC:		Person who has undertaken this assessment:
Make:	Model:	Class:
Room number:	Building:	Identification mark/number:
MSC permanently ducted to atmosphere ☐	MSC recirculates back to lab ☐	MSC can be temporarily ducted to atmosphere for fumigation purposes ☐

What biological material is handled in this cabinet?			
Hazard Group 2 or 3 dangerous pathogens	☐	Unscreened human tissues or cell cultures thereof	☐
Class 2 or 3 genetically modified organisms	☐	Human secondary cell cultures with history of safe use	☐
Screened human tissues or cell cultures thereof	☐	Other: (specify):	

Taking into account the work undertaken in the safety cabinet and the nature of any pathogen/ GMO that may be present, describe the preferred disinfection process for each of the following:

Significant spillage in cabinet (the criteria for 'significant' should be specified in the Local Code of Practice)	Airflow and filter integrity tests only	Operator protection factor test and filter integrity test only	Filter change	Other maintenance
Topical disinfection ☐ Fumigation ☐	Topical disinfection ☐ Fumigation ☐	Topical disinfection ☐ Fumigation ☐	Topical disinfection ☐ Fumigation ☐	Topical disinfection ☐ Fumigation ☐

Name the disinfectant(s) of choice for topical disinfection and cabinet fumigation. Describe the hazards of each.

	Name	*Hazards*
Topical disinfection		
Fumigation		(if formaldehyde then you can cite the table in the guidance to this form)

IF THE USE OF FORMALDEDHYDE FOR FUMIGATION OF THE MSC IS PROPOSED THEN THE REMAINDER OF THIS FORM MUST BE COMPLETED

Identify the risks associated with each stage and the control measures to be implemented

Process	*Risks (hatch those relevant, or describe others)*	*Control measures*
Prep and/ or decanting of formaldehyde solution	Exposure to formaldehyde liquid or vapour ☐ Other:	
Preparation of the cabinet for fumigation	Access to high parts of MSC required e.g. dampers ☐ MSC difficult to readily seal ☐ Other:	
The fumigation of the cabinet	No integral boiler or isolatable power socket inside MSC ☐ Poor room ventilation in case of leakage ☐ Other:	
Venting the formaldehyde from the cabinet	MSC not ducted to atmosphere ☐ Other:	

Taking into account BOTH any risk of infection AND the risks associated with fumigation reassess the appropriate disinfection process for each of the following procedures:

Significant spillage in cabinet	Airflow and filter integrity tests only	Operator protection factor test and filter integrity test only	Filter change	Other maintenance
Topical disinfection ☐ Fumigation ☐	Topical disinfection ☐ Fumigation ☐	Topical disinfection ☐ Fumigation ☐	Topical disinfection ☐ Fumigation ☐	Topical disinfection ☐ Fumigation ☐

APPENDIX D - EXAMPLE OF SOP FOR START AND SHUT DOWN OF A SAFETY CABINET

Note that this is an indicative example only and describes the operation of a safety cabinet fitted with a bypass and a manually operated damper. This example is intended for training purposes only and users will have to develop their own SOPs specific for their cabinets.

Start up

1. Ensure that the room extract ventilation is on. Whilst the MSC is off, air will be extracted via the by-pass filter above the main body of the cabinet.
2. The night door should be in place when the MSC is off. If the night door is not in place, then proceed as follows but ignore step 5 below
3. Ensure that the shut-off damper on the cabinet is in the OPEN position.
4. Depress the green 'ON-OFF' push switch on the MSC control panel. This will start the exhaust fan in the cabinet. If this does not happen then place a sign on the front of the cabinet prohibiting it's use and contact the Suite Manager or Lead Academic immediately.
5. As soon as the fan has started, ease the night door from the visor, bottom edge first, without fully removing it. This allows air to flow in at high velocity while the fan is ramping up but prevents the escape of potentially infectious materials from the front during this time.
6. The cabinet will alarm at this time and if the alarm is muted then users must ensure that the red light on the airflow diagnostic on the control panel is OFF before using the cabinet.
7. After 10 – 15 seconds remove the night door and place it in the rack under the cabinet.
8. Only when the needle on the airflow gauge is in the green SAFE zone can the cabinet be used.

Shut down

9. When work is finished it is good practice to switch off the cabinet and replace the night doors so as to prevent unnecessary use of power and so as to protect the filters in the MSC. However, if the cabinet is holding infectious material or waste, even if nobody is actually sitting at the MSC, then the cabinet fans must still be left running.
10. Once work has finished, clear the cabinet in accordance with the Code of Practice for your laboratory.
11. Remove the night door from its rack under the MSC and place it in the aperture.
12. Immediately switch off the cabinet fan by pressing the 'ON-OFF' switch. The fan will cease to run.

APPENDIX E - EXAMPLE SOP FOR FUMIGATION OF A DUCTED MSC FITTED WITH A BUILT-IN BOILER

Routine or in the event of a spillage

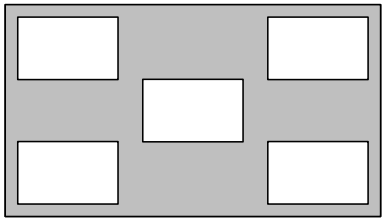
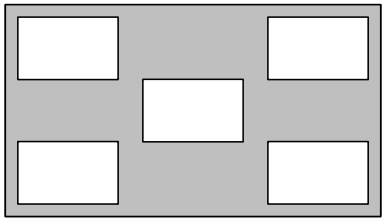
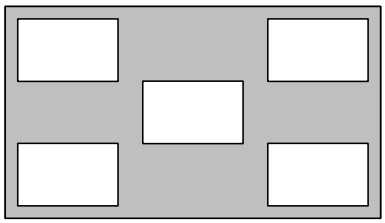
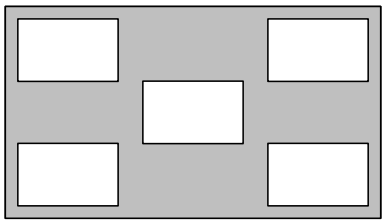
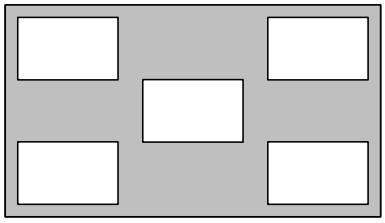
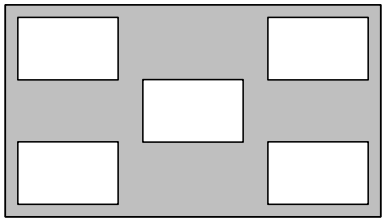
1. Leave the MSC running
2. Place the night door in the MSC front opening. The alarm will sound.
3. Switch off the MSC.
4. Tape the night door carefully to the visor panel using Duck tape. Do not use brown parcel tape as this will leave a residue of adhesive on the cabinet when it is removed.
5. Place the FUMIGATION IN PROGRESS (see below) sign on the front of the cabinet.
6. Close the manual dampers (move to the “S” position).
7. Place formalin and water in the boiler (30 mL formalin + 30 mL H2O).
8. Insert the fumigation plug into the socket and switch on at the wall.
9. Press the FUMIGATE button on the MSC.
10. Leave overnight or for at least 16 hours.
11. To purge, move the manual dampers to “O” (OPEN) and switch the cabinet on.
12. When the cabinet extract fans begin to operate, remove the tape and lift the night door slowly from the aperture.
13. The formalin should be evacuated and the cabinet safe to use after 2 hrs.
14. Remove the FUMIGATION IN PROGRESS signage
15. Wipe clean the boiler with a damp paper towel.

In the event of detecting any leakage of formaldehyde, immediately purge the cabinet using the procedure parts 11 – 13 described above.

APPENDIX F - RECORD OF MEASURED CLASS I INFLOW VELOCITIES

The inflow velocities must be measured on a monthly basis using a calibrated anemometer. These measurements are taken on all Class I cabinets (including the Class I/III hybrid) by running the cabinet and, with the anemometer held vertically in the plane of the aperture, make air velocity measurements at a minimum of 5 positions, namely in the geometric centre of the aperture and in each of the corners with the centre of the anemometer 50-55 mm from the side and top or bottom edge of the aperture.

The measured airflows at all points must be between 0.7 and 1.0 m/sec. No individual measurement shall differ from the mean by more than 20%.

Date:		
MSC ID:		
Measurements taken by:		
	 Ave _____ m/sec	 Ave _____ m/sec
Date:		
MSC ID:		
Measurements taken by:		
	 Ave _____ m/sec	 Ave _____ m/sec
Date:		
MSC ID:		
Measurements taken by:		
	 Ave _____ m/sec	 Ave _____ m/sec

APPENDIX G - RECORD OF MEASURED CLASS II INFLOW AND DOWNFLOW VELOCITIES

The inflow and downflow velocities must be measured on a monthly basis using a calibrated anemometer.

The inflow measurements are taken on Class II cabinets by running the cabinet and, with the anemometer held vertically in the plane of the aperture, make air velocity measurements at 3 positions, in the centre horizontal plane. The measured inflows at all points must be over 0.4 m/sec.

The downflow measurements are taken on all Class II cabinets by running the cabinet and, with the anemometer in the horizontal plane 100 mm above the top edge of the working aperture, make air velocity measurements at a minimum of 8 positions, namely 4 along a line one quarter of the depth of the working space forward of the rear wall, and four along a line the same distance behind the front window. The measured downflows at all points must be between 0.25 and 0.5 m/sec. No individual measurement shall differ from the mean by more than 20%.

	INFLOWS	DOWNFLOWS
Date:		
MSC ID:		
Measurements taken by:		
		
Date:		
MSC ID:		
Measurements taken by:		
		

APPENDIX H - RESEARCH DEPARTMENT COMPLIANCE CHECKLIST

The following checklist is provided so as to provide those within the research departments that are responsible for the safe use of their safety cabinets, or their lab managers, an outline of some of the key points within this Code of Practice. It is not intended to be comprehensive and to look at every aspect of the CoP, just to some of the key items. Nor is it intended to be an audit or inspection, but simply a list to help departmental managers and Principal Investigators identify gaps. These questions will however, in a similar guise, also be used as part of the College Safety Department iCHECK audits.

The correct answers to these questions are in all cases 'yes', or where appropriate 'N/A'. If you have to answer 'No' or 'Don't know' to any question then this must be rectified and your Local Safety Officer or member of the Safety Department BioSafety Team consulted.

The question set is available as a separate document for completion electronically.

#	QUESTION	ANSWER			
		Yes	No	N/A	don't know
1	Is all work carried out in your laboratory(ies) risk assessed and has the need for a MSC been included within this assessment?	☐	☐	☐	☐
2	Is all work that should be done within an MSC, carried out in an MSC?	☐	☐	☐	☐
3	Are all members of your group clear on the differences between Class I, II or III MSCs?	☐	☐	☐	☐
4	Are all members of your group clear on the differences between MSCs, laminar flow booths and fume cupboards?	☐	☐	☐	☐
5	Are all recirculating MSCs used for Hazard Group 2 or Class 2 work (or above) fitted with two independently testable HEPA filters on the exhaust?	☐	☐	☐	☐
6	Are all recirculating MSCs labelled as such?	☐	☐	☐	☐
7	Are all users clear on the restrictions as to what can be used within recirculating MSCs?	☐	☐	☐	☐
8	Are all MSCs compliant with BS EN12469 and clearly labelled as such?	☐	☐	☐	☐
9	Are all MSCs installed in full compliance with this CoP?	☐	☐	☐	☐
10	Are all MSCs turned off when not in use?	☐	☐	☐	☐
11	When selecting new MSCs will their energy consumption be considered?	☐	☐	☐	☐
12	For ducted MSCs, do you know that all extracts are positioned so as not to present a hazard to others?	☐	☐	☐	☐
13	Are all air conditioners or air supply grilles within the laboratory positioned so as not to cause disruption to the MSC?	☐	☐	☐	☐
14	Do you possess a copy of the latest test certificate for all your MSCs?	☐	☐	☐	☐
15	Was this test carried out within the last 6 months?	☐	☐	☐	☐
16	Does this test certificate cover all the relevant items as described in Table 5 of this CoP?	☐	☐	☐	☐

#	QUESTION	ANSWER			
		Yes	No	N/A	don't know
18	Are all users trained in the use of the safety cabinet and is a record of this kept (see Appendix I)	☐	☐	☐	☐
19	Is a good quality height adjustable chair provided?	☐	☐	☐	☐
20	Are workers clear on the correct working position?	☐	☐	☐	☐
21	Is a biohazard sign displayed on the MSC?	☐	☐	☐	☐
22	Is a radiation trefoil sign displayed if Ionising Radiation work is carried out in the cabinet?	☐	☐	☐	☐
23	Has a risk assessment on the disinfection of the MSC been completed (using Form MSC1) and is it on display on the cabinet?	☐	☐	☐	☐
24	Is all ionising radiation work carried out in the MSC registered with the Safety Department?	☐	☐	☐	☐
25	Is the MSC kept clean and users instructed to leave it in a tidy state?	☐	☐	☐	☐
26	Are the disinfectants required for the work always available?	☐	☐	☐	☐
27	Is any ductwork, controls or fans to your MSCs, and located within your lab space, checked at least annually?	☐	☐	☐	☐
28	Have the MSCs been tested for operator protection under conditions representative of their use? For example, was any large equipment normally in the MSC, installed at the time of the test?	☐	☐	☐	☐
29	Are monthly airflow tests carried out as required?	☐	☐	☐	☐
30	Are maintenance or service engineers issued with a Permit-to-Work prior to them being allowed to start testing or servicing the MSCs?	☐	☐	☐	☐
31	Are the MSCs rendered safe to work on through decontamination and disinfection prior to a Permit-to-Work being issued?	☐	☐	☐	☐
32	Are non-radioactive filters disposed of via the HelpDesk?	☐	☐	☐	☐
33	Are any MSCs at CL3 fitted with an UPS?	☐	☐	☐	☐
34	Are users clear on the requirement for Permits-to-Work before allowing engineers to access their laboratories and MSCs?	☐	☐	☐	☐
35	Are users clear on the requirement for decontamination certification before allowing MSCs to be removed from the laboratory?	☐	☐	☐	☐
36	Are users clear that HEPA filters must be removed from MSCs before issuing the decontamination certificate and allowing the MSC to be removed?	☐	☐	☐	☐

APPENDIX I - FACILITIES MANAGEMENT COMPLIANCE CHECKLIST

The following checklist is provided so as to provide those responsible for certain aspects of the maintenance of safety cabinets an outline of some of the key points within this Code of Practice. It is not intended to be comprehensive and to look at every aspect of the CoP, just to some of the key items. Nor is it intended to be an audit or inspection, but simply a list to help supervisors and managers dentify gaps. These questions will however, in a similar guise, also be used as part of the College Safety Department iCHECK audits.

The correct answers to these questions are in all cases 'yes', or where appropriate 'N/A'. If you have to answer 'No' or 'Don't know' to any question then this must be rectified and your DSO/FSM/CSM or member of the Safety Department BioSafety Team consulted.

The question set is available as a separate document for completion electronically.

#	QUESTION	ANSWER			
		Yes	No	N/A	don't know
1	Has this Code of Practice distributed to all Maintenance Team Leaders?	☐	☐	☐	☐
2	Are all relevant FM staff members aware of the general principles of this CoP?	☐	☐	☐	☐
3	Have all relevant FM staff members attended the Safety Dept course on 'Fundamental Principles of Local Exhaust Ventilation for Maintenance and other support staff'?	☐	☐	☐	☐
4	Are all safety cabinet ducts external of the research laboratories labelled so as to allow quick and accurate identification of which ducts serve which cabinets?	☐	☐	☐	☐
5	Are all Maintenance staff instructed to report any damage or faults they may suspect or identify to any ductwork that does or could serve an item of Local Exhaust Ventilation?	☐	☐	☐	☐
6	Are the ductwork, controls and fans to your MSCs labelled so as to allow clear identification of which duct serves which cabinet?	☐	☐	☐	☐
7	Are FM PTW issuers clear that should any work be required to the cabinet extract systems located outside of the laboratory, the PTW must be signed off by the Lab Manager as well as the PTW issuer?	☐	☐	☐	☐
8	Are FM clear on the requirement for decontamination certificates before removing MSCs for either relocation or disposal?	☐	☐	☐	☐
9	Are FM clear that all filters must be removed from the MSC before disposal of the cabinet?	☐	☐	☐	☐

APPENDIX J - USER TRAINING CHECKLIST EXAMPLE

The following list covers the minimum level of training that all MSC users should be provided with.It is essential that those responsible ensure levels of competency before authorising their staff or students to work alone at the cabinet. A record of this training must be maintained and this page can be used for that purpose.

#	SUBJECT	ITEM COVERED	COMPETENCY ASSESSED
1	This CoP has been issued	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
2	Different cabinet types and how they work	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
3	Control panels, alarms and indicators - what they all mean	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
4	How to turn the MSCs on and off	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
5	Local rules on whether the MSCs are left on or off	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
6	Permitted equipment allowed within the MSCs	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
7	Local rules on restrictions on use of particular cabinets	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
8	Dealing with waste within the safety cabinet	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
9	Restrictions on what work can be carried out in recirculation MSCs	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
10	Dealing with spillages within the safety cabinet	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
11	Routine cleaning of the MSCs after use	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
12	Fumigation of the MSCs	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
13	Monthly airflow testing of the Class I MSC(s)	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
14	Monthly airflow testing of the Class II MSC(s)	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
15	Maintaining the logs of monthly airflow tests	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐
16	Principles of engineer airflow and operator protection testing	Yes ☐ No ☐	Yes ☐ No ☐ N/R ☐

BOTH TRAINER AND TRAINEE HEREBY AGREE THAT THE ABOVE TRAINING HAS BEEN FULLY COMPLETED AND THAT ALL THE POINTS IDENTIFIED ABOVE AS HAVING BEEN TAUGHT AND UNDERSTOOD, HAVE IN FACT BEEN COMPLETED.

POSITION	NAME	SIGNATURE	DATE
Trainer			
Trainee			

Selection, Use and Maintenance of Microbiological Safety Cabinets

First issued 2005
Revised 2011

Imperial College London
Safety Department
Level 5, Sherfield Building
South Kensington Campus
London SW7 2AZ

imperial.ac.uk/safety