Standards for containment level 3 facilities

Version 1 2014

Contents

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Introduction

Containment laboratories must be designed and built so as to prevent or control the exposure of laboratory workers, other persons and the environment to the biological agent in use. Biological agents (as defined by the Control of Substances Hazardous to Health [COSHH] Regulations) have been categorised by the Advisory Committee on Dangerous Pathogens (ACDP)[1] into four Hazard Groups (1 being the lowest, 4 being the highest risk) on the basis of their infectivity and the consequences of such infection. The levels of containment usually required for work with such agents are determined by their categorisation (Containment Level [CL] 3 is required for Hazard Group 3 pathogens) and these reflect the increasing levels of health risk to those involved in (or who could be affected by) such work. Work with animal pathogens is similarly classified into groups 2-4 with group 4 being the highest risk level. The Department for Environment, Food and Rural Affairs (DEFRA) determines the classification of animal pathogens under the Specified Animal Pathogen Order (SAPO)

Genetically modified organisms are categorised under the Genetically Modified Organisms (Contained Use) Regulations using similar criteria for categorisation according to the likelihood and consequence of exposure to humans or the environment and, as such, require facilities similar to those specified under COSHH. The specifications for laboratories used for genetically modified organisms are provided by The Scientific Advisory Committee on Genetically Modified Organisms (Contained Use) – SACGM (CU) (formerly ACGM).

Every CL3 laboratory has two physical layers of containment. The primary barrier (safety equipment), which will contain the hazard at source, and the secondary barrier (the laboratory itself), the design of which is essential in protecting both the worker and those outside the laboratory. It is also important to recognise that the secondary barrier also represents a security barrier that prevents all but those who are fully trained and competent to enter unless fully supervised.

Whilst ACDP[2] [3] and ACGM[4] guidance documents describe good practice in the design and use of containment laboratories, they do not provide a detailed guide on their design and construction. This document, which should be read in conjunction with the ACDP, ACGM and Animal Pathogens Guidance on Controls 2012[5] documents, provides further details of the standards specifically required by the MRC and/or BBSRC in the building or refurbishment of CL3 laboratories.

[1] Advisory Committee on Dangerous Pathogens 'The Approved List of Biological Agents' 2013.
[2] Advisory Committee on Dangerous Pathogens 'The Management, Design and Operation of Microbiological Containment Laboratories' 2001 HSE Books
[3] Advisory Committee on Dangerous Pathogens 'Biological Agents: managing the risks in laboratories and healthcare premises' 2005
[4] Advisory Committee on Genetic Modification 'Compendium of Guidance' 2000
[5] Animal Pathogens: Guidance on Controls: March 2012

Standards in the design and construction of containment level 3 facilities

Preliminaries and management issues

Element	Functions and properties
1. Risk assessment	This is the essential first step for determining the level of risks the proposed work will present. Users should conduct a risk assessment with regard to all aspects of the work (such as the use of biological agents, ionising radiation, equipment or harmful chemicals) to be conducted in the facility. This assessment will form the basis of the design for the laboratory. Any derogation from the control measures specified in COSHH must be justified in this risk assessment. In addition, work with SAPO 3 animal pathogens requires that Standard Operating Procedures are in place prior to work commencing. The usability and ergonomics of the facility and the equipment layout must be also be considered. A separate risk assessment, conducted by the contractors, must address all the possible hazards relating to the design, construction, and maintenance of the facility.
2. Consultation with users and duty-holders	To ensure the facility meets functional requirements. A user representative should be appointed to liaise with the design team and Project Manager. Regular and frequent meetings must be held throughout the duration of the project. The Project Manager must ensure that all duty holders are consulted throughout the design process and their approval is documented at each design stage.
3. Siting of the CL3	The CL3 facility must be separated from any other activities in the same building and away from public thoroughfares. Normally a CL3 suite will be within other laboratory space (ideally within a CL2 laboratory) or in an area segregated from other areas. It cannot be in or entered via an administrative or recreational area. A lobby (anteroom) to each CL3 laboratory provides another level of segregation from other areas and must be installed in all facilities (see below). A SAPO 3 laboratory must have an air lock that separates the facility from the surrounding environment. An interlocking mechanism must be in place to prevent entrance doors to the surrounding environment and to the laboratory being opened at the same time. The airlock separates the clean and dirty sides of the laboratory. Additionally a CL3 laboratory must not be sited close to any fire risk and should not be positioned where flooding is a risk. Any issues regarding ease of access for services and their maintenance must be considered when identifying the siting of the laboratory or suite. The location of a CL3 suite in relation to other sources of significant pressure changes within a building must be considered; for instance, a lift adjacent to a CL3 can cause fluctuations in air pressure differentials within the laboratory.
4. Maintenance	To ensure the continued safe working of the facility. Consider the maintenance capability of the clients. As a general rule, simplicity of design from the point of view of lab structure and mechanical and electrical installations must be achieved.
5. Security	To ensure an adequate level of security to the laboratory contents and the workers It is essential that all CL3 laboratories are secure. In addition a SAPO 3 laboratory must be protected with an intruder alarm. A key must be held centrally in case there is a need for emergency access.

It will be necessary to ensure that should the material being handled within the laboratory be classified as a 'dangerous substance' under the Anti-Terrorism, Crime and Security Act 2001, that the criteria as laid out in the Security Standards for Laboratories'[5] are fully complied with. If the material to be handled is a dangerous substance then it is Important that the Client representative or Project Manager contacts their local CTSA

6.Space norms and allocations

To ensure the provision of adequate space for each worker.

Adequate space in these areas is especially important to allow comfortable and safe use of the facility by all personnel whilst minimising the impact of their activities on each other and on the function of safety equipment (such as microbiological safety cabinets [MSC]). In calculating space requirements consideration must be given to space lost to equipment and the nature of the activities to be undertaken.

As a guide, 10m^2 should be adequate space to accommodate one person and standard equipment required in a CL3 lab (MSC, benching, incubator, freer, centrifuge). A second person may require slightly less space as certain pieces of equipment may be shared.

[5]'Security Standards for Laboratories, subject of Part 7 of the Anti-Terrorism, Crime and Security Act 2001' Home Office, Restricted. To obtain a copy of the standards, contact the Counter Terrorism Security Adviser (CTSA) at nactso@cpni.gsi.gov.uk

Containment

Element	Functions and properties
7. Negative pressure differentials between the laboratory and outside rooms	To provide containment. Note that whilst negative pressure differentials are a requirement under the COSHH and the SAPO Regulations, a negative pressure in a lab will not in itself produce the protection needed. Protection is achieved by maintaining a flow of air into the room, away from the user and towards the source of potential contamination.
8. Air inflow through the doorway	To maintain containment when the door is open. Although a sealed laboratory running at negative pressure will prevent the escape of airborne pathogens when the lab door is closed, special consideration must be given to when the door is open. A constant inward airflow through the open door will minimise the risk of breach of containment in the event of having to leave the room in an emergency. This is most easily achieved by only supplying air through the door itself i.e. the air is drawn passively through a transfer grille in the door. See Appendix 1 for further details.
9. Lobbies to CL3 facilities	A magnehelic gauge or similar device should be installed to give a constant visual indication of this negative pressure to provide an increased level of protection to those outside the laboratory. A CL3 lobby will significantly improve the laboratory protection factor (by $>10^2$). These are also designated as clean areas and can house washbasins and supplies such as clean protective equipment. A lobby provides an additional level of control of the flow of air into the laboratory whilst workers are entering or exiting the facility. This is important as fluctuations in air patterns within the laboratory can affect the safe performance of MSCs.

Most work with agents in Hazard Group 3 will be conducted in a safety cabinet or isolator. This is especially important where aerosols can be produced. This equipment provides the primary containment for working with biological agents.

There are four types of MSCs

• Class I: Protects the operator only. These are open fronted and air is drawn in entirely via the front opening.

• Class II: Protects both work and operator. These are open fronted and air is drawn in via the front but is drawn through a HEPA filter before being blown over the work. These must be used with caution with HG3 pathogens. The risk assessment will determine the class of MSC that can be used.

• Class III: Offers maximum protection to both the user and the work. These are fully enclosed with glove ports and air is drawn into the cabinet via a HEPA filter. The operator is therefore segregated from the work by a solid barrier

• Class I/III: A hybrid cabinet that is capable of running in either Class I or Class III mode. All microbiological safety cabinets within a SAPO 3 laboratory must be exhausted to the outside via a HEPA filter. Recycling cabinets must be sited with care to ensure a fumigant can be extracted to the outside.

All safety equipment must be installed and commissioned in accordance with the appropriate standards and guidance. Further details are provided below in the section on Commissioning.

Note 1: Clean Air cabinets or Laminar Flow hoods are NOT safety cabinets as they are designed to protect the work and afford no protection on the user. These must never be installed in CL3 laboratories.

Note 2: The Roman numerals I, II and III apply to MSC Classes whilst 1, 2 and 3 apply to containment levels (CL) only.

Note 3: The term P (as in P3) is not applicable to Containment laboratories in the UK and therefore must not be used. Category 3 refers to the pathogen in use and not the facility.

11. Fully sealed laboratory

An essential factor in providing Secondary Containment of the biological agent in use and in allowing fumigation of the laboratory

A sealed laboratory will provide a further barrier in preventing the accidental release of the biological agent. Additionally a SAPO 3 laboratory or facility must be proofed against the entry or exit of insects and/or animals.

Room fumigations are usually conducted with formalin (formaldehyde) or Vaporised Hydrogen Peroxide (VHP) and are carried out for three reasons;

• Emergency disinfections following a spillage.

• Routine disinfection to allow servicing, change of micro-organisms, etc.

• Commission/decommissioning a laboratory.

Formaldehyde and VHP are very hazardous substances and are used at concentrations above the accepted safe levels. As a consequence CL3 labs must be sealed to prevent leakage of the gas. In order to obtain a fully sealed lab, the following factors must be considered;

• All possible routes of gas escape must be identified and suitable sealing measures taken. This means sealing around all penetrations into walls, ceiling and floor, including attention to "hidden" penetrations such as those behind sockets etc.

• Penetrations must be kept to a minimum.

• All non-essential services must be diverted outside the laboratory.

• Drains should be avoided but if found to be necessary (according to user requirements and following risk assessment) they need to be made gas proof by the use of traps etc.

• Walls, ceiling and floor materials must not absorb and then slowly leach gases such as formaldehyde, which can be harmful in low concentrations.

• Other gas traps, such as boxed in services, e.g. electrical services in dado trunking, and suspended ceilings, must be avoided.

• All materials used for sealing must be resistant to disinfectants.

• It must be possible to operate the air handling system from outside the room to allow venting the fumigant without having to enter the lab.

Careful consideration must be given to the substitution of formaldehyde with a safer alternative. Vaporised Hydrogen Peroxide (VHP) or Chlorine dioxide (CD) may be a suitable alternative in certain circumstances. However, the Biological Safety Officer must be consulted before any decisions to employ VHP or CD are made.

Fabric

Element	Functions and properties
12. Walls	Are major component of the laboratory envelope. These must be designed and installed with the sealability of the lab as the primary consideration. Suitable materials must always be used. There are a number of specialist materials and techniques available on the market. These include (in no particular order): • Vinyl cladding • PVC sheeting • Steel panels (of the type used in the nuclear industry) • Polymer paints If the use of plasterboard, in the absence of any overlying cladding (such as vinyl) is proposed then the following issues must be considered; • Plasterboard is susceptible to physical damage and absorbs formaldehyde. • Joints between boards are susceptible to movement and can crack. • The method by which any penetration will be sealed must be demonstrated. Achieving a satisfactory and long-lasting seal around a penetration in plasterboard is difficult. If cavity walls are installed then any penetrations must also be sealed within the cavity. Take into account building movement and flexibility of the laboratory structure when choosing materials. Walls must be easy to clean and be water and solvent impervious as well as resistant to common disinfectants (e.g. hypochlorites and proprietary agents such as Virkon). These must also be impervious to fumigation agents such as formaldehyde, vaporised hydrogen peroxide or chlorine dioxide. The wall material selected must be appropriate to provide the required levels of security control.
13. Flooring	To contain and prevent loss of spillage to other floors chemically resistant vinyl flooring must be used. These must have completely sealed joints and coved the walls to ensure the gas- tight seal. Any penetrations through the floor should be coved or, as a minimum, sealed with non-hardening sealant. The floors must be easy to clean.
14. Ceiling	Primarily to complete the "box" which makes up the gas- containing vessel and to support services etc. It must be sealed - i.e. of one sealed piece not tiles. Any joints must be totally sealed. Any penetrations (air supply, extract cabinet extract, gas supplies etc.) must be totally sealed. Sealants must be of good (suitable) quality, non-hardening and chemical resistant. The number of penetrations through the ceiling must be minimised.
15. Ceiling voids and spaces	Provide space for services etc. Ceiling voids must never be considered as part of the sealed laboratory space. When testing the laboratory seal, these voids must be accessible from the outside the laboratory for inspection of the ceiling integrity.

16. Corners and joints between walls, floor and ceiling

To ensure complete physical containment.

Special consideration must be given to all joints, as these are the most common source of leaks. They must be completely sealed, cleanable and durable. Building movement must be taken into account when choosing materials.

Double seals for these joints should be considered, when appropriate.

17. Sealing of penetrations

To prevent leakage of gas and liquids

When designing a CL3 laboratory consider ;

• The necessity for any particular penetration, none essential penetrations should be avoided.

• Minimise the necessary penetrations e.g. bring lighting power through at one site only.

• Any penetrations that are necessary must be sealed using proprietary fittings e.g. IP68 rated glands for electrics and pipework. The use of these allows the least possible reliance on silicone.

• Any silicone used must be of the highest quality and must remain flexible and resistant to disinfectants, fumigants and cleaning agents.

18. Doors

Allow access to the facility and working rooms.

These must be easily sealable for fumigation purposes. This can be achieved by either using doors fitted with seals or, by taping the door and frame edging when required. If supplied, seals must be robust during use (e.g. floor level seals must stand up to repeated opening and closing) The door must be of rigid construction to ensure that the seal is maintained at all times.

The materials for door and frame must be disinfectant/fumigation proof and capable of withstanding repeated application and removal of tape. Door closers, hinges, handles and locks must be positioned so as not to clash with the areas requiring sealing.

A sealed vision panel must be present in the door.

Any air transfer grilles required should be considered when choosing door type; both door and grille must comply with fire regulations. An externally fitted blanking plate for sealing the transfer grille during room fumigations should be provided.

Doors must be of adequate size to allow installation and removal of equipment. If required, a door plus leaf can be installed but must meet closure standards for sealing purposes.

Where reasonably practicable, doors must be interlocked to prevent both the inner laboratory and outer lobby door to be open simultaneously.

19. Windows and vision panels

To allow access to natural light.

Vision panels are usually located to allow viewing of workers within the laboratory at all times without having to enter.

All internal windows and vision panels must be secured and fully sealed to ensure gas tightness. These vision or window panels must comply with fire and security requirements.

External windows must be secured and fully sealed to ensure gas tightness. They should preferably be double-glazed and the internal surfaces should be smooth to allow cleaning.

20. Air supply and extract including air through-put

To provide suitable quality air and the containment needed at all times

This is probably the most crucial aspect of CL 3 and is discussed in more detail in Appendix 1.

21. Filtration

To protect the environment from contamination and, if needed, to provide clean air to the facility.

All air leaving the containment room MUST be HEPA filtered. See Appendix 1.

'Safe change' HEPA filter systems should be considered whenever possible.

Supply air can be filtered (at least to H3 standard) although this is not a requirement for biological containment and some users may not require inward HEPA filtration for quality purposes.

22. Systems for controlling air handling

Making the room work safely!

All aspects of air supply and extract must be capable of being controlled from outside the lab. Whenever possible these should be independent of the BMS but if connected then safe guards – preventing unauthorised adjustment – must be in place. All gas-tight shut off dampers must be controlled from outside the lab. These controls must be easy to use and sited to prevent unauthorised use.

It should be possible to control the MSCs from outside the facility. Alarms for room supply and extract must be audible from inside the laboratory

A magnehelic gauge measuring pressure difference between the lab and the environment (immediately outside the lab) must be positioned in the clean side of the door to the laboratory or the lobby and either within the laboratory itself or visible from within the laboratory.

23. Fume cupboards

May be required for controlling exposure to hazardous or flammable chemicals

The use of fume cupboards at CL3 is unusual.. Most work that requires a fume cupboard can be conducted within a ducted Class I cabinet. Installation of a fume cupboard must be subject to a risk assessment by the users and, if installed, HEPA filtration is required.

24. Access controls

Access should be restricted to authorised users only.

The laboratory room must remain "locked" when not in use.

Access to the facility must be controlled, preferably locally, through a swipe or proximity card, or push button system. If connected to swipe card systems then these must remain locked in the event of fire. Emergency release mechanisms (preferably mechanical) must be installed so as to allow egress at any time.

The design of the access control system must be in accordance with current Home Office requirements.

25. Benching, bench frames

To work on and to support any equipment.

These must be impervious to water and solvents and must be easy to clean. All joints must be sealed and the frame itself must be rigid and capable of supporting equipment such as MSCs and centrifuges.

The benches must be designed to allow comfortable working and of a height to accommodate under bench equipment.

26. Shelving and cupboards

Storage space should be kept to a minimum. Where cupboards are provided they must not be gas tight. Under bench units should be easily moved for cleaning and access to services or fixed to the floor.

27. Access to service voids

Maintenance and repair of services not within the laboratory itself.

Sufficient provision should be given to allow for inspection and maintenance. Services/utilities must be designed and installed, so far as is reasonably practicable, in such a manner to not necessitate the entrance of maintenance staff (or any other 'non-authorised' persons) into the CL3 laboratory.

Any equipment that does require inspection or servicing must be easily accessible without causing any damage to the laboratory envelope. Any inspection hatches required must be fully sealed and tested for sealability.

28. Gas supplies (e.g. CO2 for incubators)	For incubators and other equipment. Supply should be located external to the room and fed through pipe work. These penetrations must be fully sealed. The risk assessment will determine the need for gas monitors. If fitted the alarms from these must be audible inside and outside the laboratory.
29. Fumigant test ports	Allow the measurement of fumigant levels without the need to enter the laboratory. A port should be provided, usually in the laboratory to corridor or lobby door. This must be wide enough to allow the insertion of a gas meter probe. The port must be fully sealed, screw capped and fitted with an 'O' ring. It should be positioned approximately 1 metre off the ground.
30. Laboratory sinks	Disposal of decontaminated liquid waste. Installation of sinks in CL3 laboratories must be subject to risk assessment. Such sinks are not for disposal of contaminated material and all material disposed of to drain from both types of CL3 facilities must be sterilised or decontaminated before disposal. Caustic or corrosive materials, e.g. hypochlorite will be poured down these sinks and, consequently, they must be constructed of materials resistant to these chemicals. Taps can be of the conventional laboratory type touched by gloved hand.
31. Wash hand basins	Hygiene facility for hand washing. Separate wash hand basins must be as close to the exit (for example in the lobby) as possible so that staff need not touch any potentially contaminated surfaces following hand washing. There could be a conflict here with door handles on "internal" doors leading to vestibules and if identified by risk assessment (conducted by the users); two wash hand basins should be installed.
32. Wash hand basin taps	Must allow operation without the need for using hands. Elbow, foot or PIR operated systems which do not require hand touching should be used. Warm water must be pre-mixed to a comfortable temperature and the pressure limited to prevent splashing.
33. Soap and towel dispensers	Hygiene facility. Dispensers for soap (preferably hands free) and disposable paper towels should be permanently installed immediately adjacent to the basin(s). Automatic hand dryers are preferred in the lobby over towels.
34. Emergency shower	The installation of an emergency shower within or near a CL3 laboratory will not be required in the majority of situations. The work carried out will determine its requirement. As routine, only hand-held flexible hose showers should be installed; the most convenient place being by the wash hand basin in the lobby. This can be used for body and eye wash. The alternative option of installing it within the laboratory itself could be considered.
35. Lighting	Should be suitable for "wet areas". The covers/outer surfaces should be resistant to fumigants. Note the positioning of the luminaires is crucial. Shadows over workstations must be avoided.
36. Light switches	Can be sited inside or outside the laboratory but should be installed to ensure that all wires and conduits entering the laboratory are properly sealed to ensure fumigant cannot escape.
37. Temperature control	Comfort of workers and effective performance of equipment. A comfortable working environment must be provided. Thermal comfort is of particular importance and must be carefully considered. The overriding consideration when designing such a system must be simple. See Appendix 1 for air-handling options.

38. Noise levels

In providing a comfortable working environment noise output from all equipment must be considered and adequately controlled. A noise risk assessment should be carried out when normal speech communication is difficult.

39. Signage

Adequate and accurate safety signage must be provided. Details of emergency contact arrangements must also be clearly displayed.

40. Security

All CL3 facilities must be secure and access must be strictly controlled.

The Georgian wired glass fitted in some door panels and to any observation windows in laboratories is not security glass and will break like normal float glass if struck. Laminated glass, minimum thickness 7.5mm (resistant to manual attack) and installed in accordance with BS6262, should be fitted in all doors where a 'thumb turn' lock is internally fitted and to any CL3 laboratory observation windows. Ensure fire regulations are not breached when fitting new glazing.

It is recommended that the design team include security personnel or at least consults them when required. Those laboratories containing 'dangerous substances' as defined under the Anti-Terrorism, Crime and Security Act will be subject to additional and specific standards (see page 7 for CTSA contact details).

41. Communications

Normal and emergency communication.

The movement of pens, notepaper and other documentation out of the CL3 suite will not normally be permitted.

Data points must therefore be provided as per user requirements. If significant numbers of sockets are required then consideration should be given to the installation of a hub within the laboratory space to minimise the penetrations through the lab seal.

Hands free telephones/intercoms are preferred as touch systems can become contaminated.

The need for the provision of an emergency panic button must be considered.

The users should also consider the need for web cams or CCTV.

42. Fire detection and alarms

CL3 laboratories must have emergency exits and be fitted with smoke detectors.

Fire alarms must be present in both the lobby and laboratories.

Use

Element	Functions and properties
43. PPE – gowns, aprons, gloves – provisions for supply and disposal	Provision must be made for sufficient lab coat hooks both within the lobby and the laboratory itself. Adequate storage space for clean PPE must be provided within the lobby and laboratory. Laboratory gowns must fit tightly around the wrists. Gowns must be autoclaved before they are removed from the CL3 laboratory.
44. Equipment other than MSCs	e.g. centrifuges, incubators, freezers, fridges. The users will select these. Consideration will need to be given to service supply, e.g. CO2 gas. There will be safety considerations to take into account, centrifuge rotor-sealing etc. Heat output from these must be included when considering cooling requirements.
45. Alarm systems for equipment	e.g. for fridges and freezers To prevent the loss of samples in the event of a freezer or fridge failure.
46. De-contamination of surfaces (walls, floors, benches)	To render surfaces free of potentially infectious organisms. All surfaces will need periodic decontamination, either by topical disinfectants or by gas and therefore must be resistant to any such materials.

Waste management

Element	Functions and properties
47. Autoclave	Decontamination of potentially infectious waste. It is a requirement that autoclaves are sited within the CL3 facility. If this is not possible then derogation must be sought from HSE. Additionally waste should be removed from the laboratory following autoclaving as soon as it's practicable for incineration. An autoclave should be situated in the lab but if not possible then in the suite. The autoclave must be compliant with BS 2646, BS EN12347 and BS EN 61010-2-041 but does not necessarily have to be HTM2010 compliant. For options on locations see Appendix 2.
48. Waste collection and disposal	Should be via clearly defined routes and operate under a well- managed system. All CL3 laboratory waste must be rendered non- hazardous prior to incineration. Autoclave tins should be robust with clipped lids to prevent accidental spillage. Provision should be made to accommodate such systems easily.
49. Disposal of non-infectious waste	All waste must be considered to be potentially hazardous. Everything must be decontaminated and rendered safe using a validated means prior to its removal from a CL3 or SAPO3 laboratory. Validation in this context refers to the disinfectants in use and the autoclave, with the latter the loads should be validated using the 12 point thermocouple test.

Maintenance and servicing

Element	Functions and properties
50. Maintaining the facility	The levels of servicing to any new facility must always be constrained by the levels of support that can be provided by the institution. CL3 and SAPO3 laboratories require careful and extensive decontamination in order to allow access to maintenance personnel. If this needs to be done frequently then the consequent loss of effective time available for research can be considerable. As a guideline, the work within a CL3 laboratory should only ever need to be run down every 6 months to a year so as to allow performance testing of MSCs or autoclaves.
51. Cleaning of the room	CL3 laboratories are cleaned by lab staff – never by conventional cleaning staff. As such, the design of the laboratory and choice of materials must facilitate the rapid and frequent cleaning of such facilities. No dry brushing. Wet mopping or static sweeping only.

Commissioning

The laboratory and its equipment must be tested in order to ensure that the standards specified by the research group, department and HSE have been met before work commences. Besides carefully assessing the general standard of workmanship, a number of key aspects must be tested.

The laboratory must be leak proof and able to withstand the load characteristics imposed by the negative pressure. Drawings of sealing details should be made available at an early stage so that faults at the testing stage are minimised. All seals, around windows, pipework, electrics, etc. will be visually checked and smoke tested under static pressure. Negative pressure whilst applying smoke to the outside of the laboratory is also an option. These tests shall be carried out by a competent commissioning team together with representatives of the contractors. Dates for these tests, which shall run a number of times throughout the period of work, shall be specified at the design stage. A time-limited 'certificate of sealability' shall be issued if the room passes.

The exhaust and supply ductwork must be pressure tested pre HEPA and certified for leak-tightness. This will be done by a specialised engineer. All seals around HEPA filters, fans and dampers must also be tested and the effectiveness of the dampers in preventing reverse airflows established.

All control systems must be fully tested and commissioned by the installing engineers. This must be proved and demonstrated to the client. This includes all shutdown and start-up controls, damper controls, flow adjustments and remote cabinet switches.

All HEPA filters must be tested by certified engineers to ensure that they meet the required specifications after installation. BS: EN 14644 part 3.

All alarm systems, for example for air systems failure, electrical failure, fire or improperly opened doors must be checked.

All environmental control systems must be tested while all possible temperature-altering pieces of equipment are in operation.

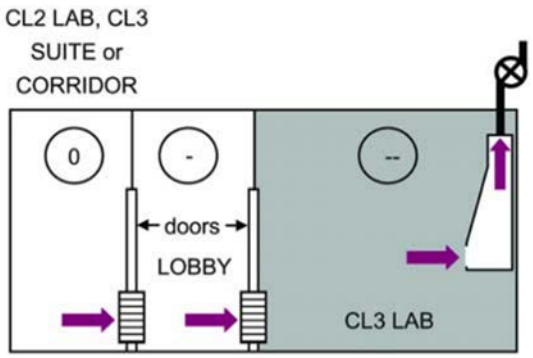
Microbiological safety cabinets must be fully commissioned and performance tested to BS5726 and BS EN12469: 2000. For open- fronted cabinets the operator protection test must be conducted under conditions which mimic those encountered during normal use as specified in the ACDP publication 'The management, design and operation of microbiological containment laboratories', page 62. An independent testing engineer must perform these tests.

Following installation, autoclaves must undergo full compliance testing to meet the requirements of relevant British and European Standards. Validation should be through the use of thermocouples using representative loads.

Appendix 1. Schemes for handling air extraction and supply in CL3 labs – the pros and cons

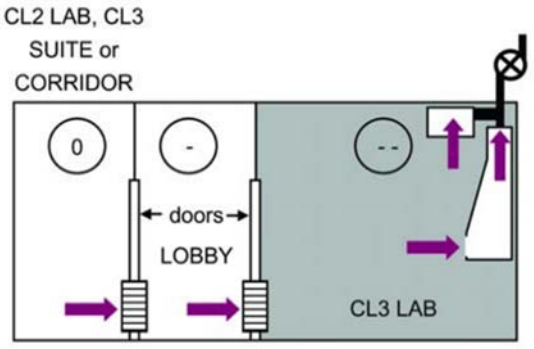
Ventilation scheme 1

Extract	Supply	Diagram	Pros	Cons
Cabinet only	Drawn passively through transfer grilles only	(Side view schematic)	•Good air flow velocities through open doors- hence good containment •Low maintenance •simple to operate •Most cost effective scheme	•Lab only under negative pressure whilst cabinet is on •Comfort cooling is limited to that already provided in the outer lab or corridor



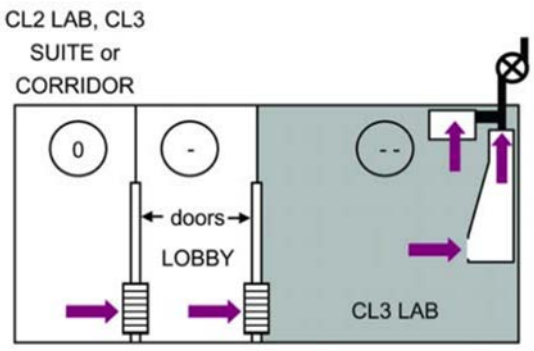
Ventilation scheme 2

Extract	Supply	Diagram	Pros	Cons
Cabinet and automatic bypass	Drawn passively through transfer grilles only	(Side view schematic)	•Good air flow velocities through open doors- hence good containment •Constant airflows in the CL3- even when cabinet is not in use •Low maintenance •Simple to operate •Highly cost effective	•Lab only under negative pressure whilst cabinet is on



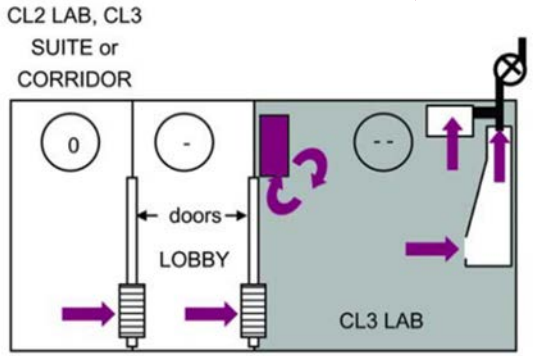
Ventilation scheme 3

Extract	Supply	Diagram	Pros	Cons
Cabinet and automatic bypass	Drawn passively through transfer grilles only but cooled and filtered air supplied into outer CL2 or corridor	(Side view schematic)	•Good air flow velocities through open doors- hence good containment • CL3 lab cannot over pressurise •Cost effective scheme •Simple to operate	• Comfort cooling will be dependent on air flows in the lab



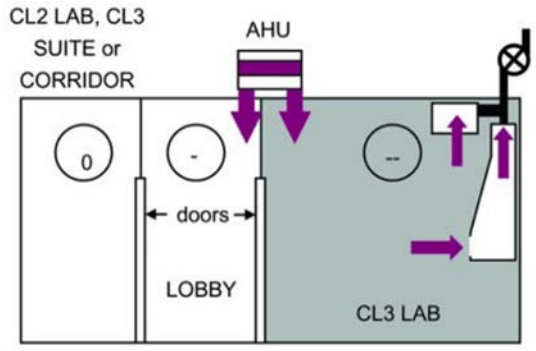
Ventilation scheme 4

Extract	Supply	Diagram	Pros	Cons
Passive supply with re-circulating cooler in the laboratory	Air cooled within the lab itself. Correct siting is essential to prevent perturbing airflow in the MSCs. The cooler should be operable from outside the lab	(Side view schematic)	•Good air flow velocities through open doors-hence good containment •CL3 lab cannot over pressurise •Cost effective scheme •Simple to operate •Good levels of comfort cooling	• Recirculating air conditioners can create high air velocities (>0.3m/s) so their use must be carefully considered and only then if absolutely required •Recirculating air conditioner must be carefully positioned so that the of performance of the MSCs is not affected



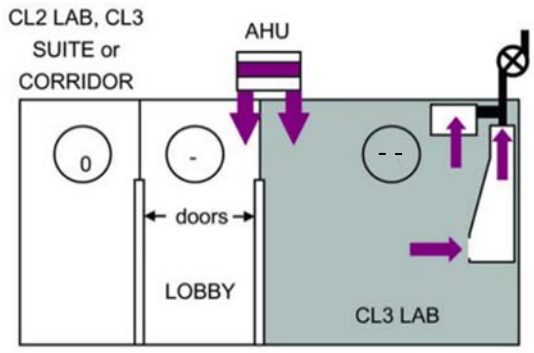
Ventilation scheme 5

Extract	Supply	Diagram	Pros	Cons
Cabinet and automatic bypass system	Cooled and filter air supplied directly into CL3 lab and lobby	(Side view schematic)	•Good levels of comfort cooling	• Recirculating air conditioners can create high air velocities (>0.3m/s) so their use must be carefully considered and only then if absolutely required •Recirculating air conditioner must be carefully positioned so that the of performance of the MSCs is not affected



Ventilation scheme 6

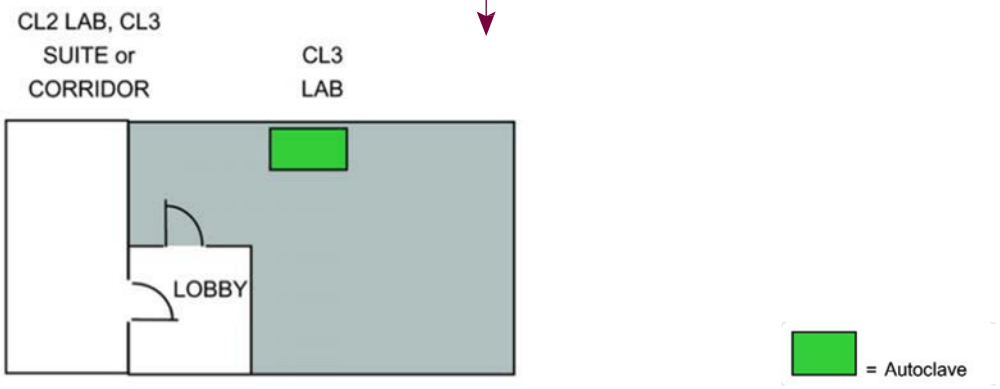
Extract	Supply	Diagram	Pros	Cons
Cabinet and room extract	Cooled (and filtered) air supplied directly into the CL3 lab and lobby	(Side view schematic)	•Good level of comfort cooling •Good for large rooms with more than one MSC •Good flexibility more MSC's and/or movement of MSC's possible	Difficult to achieve good air inflow when door is open •Complicated to install commission and operate •Higher level of maintenance to ensure balance of air flows. •Most expensive scheme to install and commission.



Appendix 2. Waste disposal and autoclave siting in CL3 labs and suites

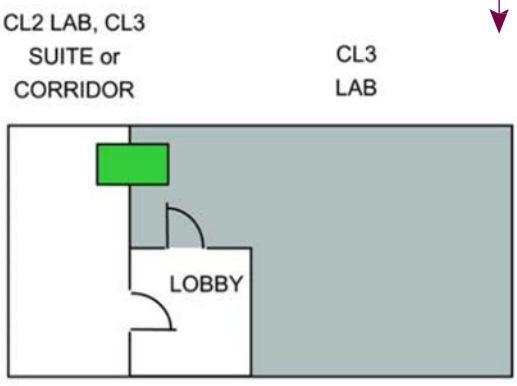
Autoclave scheme 1

Autoclave siting	Diagram	Pros	Cons
Within the CL3 lab	(Plan view)	•First preference in ACDP and HSE guidance •Allows easy, efficient and safe disposal of waste •Can be cost effective if simple, effective machines are used	•If operated whilst users are in the lab, then heat output must be accounted for in cooling provision •Can create unpleasant smells for those in the lab



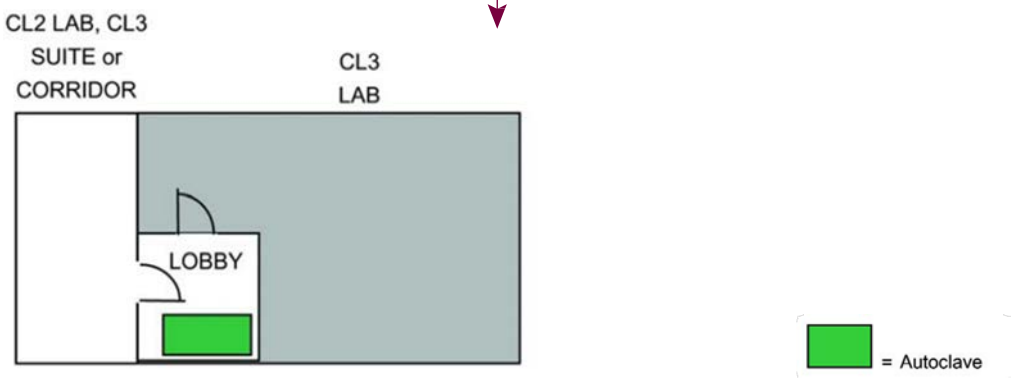
Autoclave scheme 2

Autoclave siting	Diagram	Pros	Cons
Double-ended autoclave 'dirty' and 'clean' side	(Plan view)	•Complies with first preference in ACDP and HSE guidance •Allows clear easy separation between 'dirty' and 'clean' handling waste •Allows for rapid and safe disposal of waste •Engineers can access from outside the lab	•Heat output must be accounted for in cooling provisions •Double-ended autoclaves are expensive to purchase and maintain •A gas-tight seal (for fumigation disposal of purposes) around the autoclave can be difficult to achieve and maintain



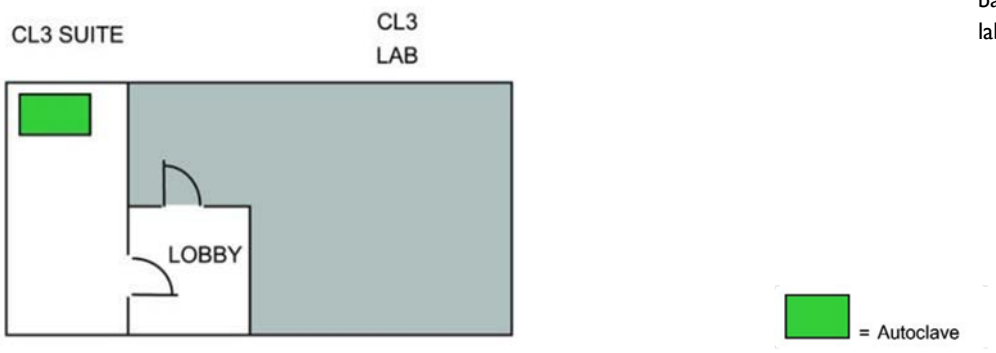
Autoclave scheme 3

Autoclave siting	Diagram	Pros	Cons
Autoclave in lobby	(Plan view)	•Segregated from non-authorised users •Local cooling can minimise heating effects on the CL3 lab	•The lobby must be considered a 'clean' area and therefore waste must be transported in containers which can be opened to allow the penetration of steam •Can limit space within the lobby



Autoclave scheme 4

Autoclave siting	Diagram	Pros	Cons
Autoclave is elsewhere in suite. Note this is only an option if the lab is within a multi-lab CL3 lab	(Plan view)	•Allows for provision of a single autoclave facility for multiple CL3Labs within the suite •Heat output from autoclaves can be easily isolated from workers	•Waste must be in transported to the autoclave in sealed leak proof containers. Provision must be made for a secure place if these containers need to be safely opened for steam penetration •Creates 'usability' problems e.g. a booking scheme for these autoclaves will be in operation. Any waste that cannot be autoclaved immediately must be taken back to the source laboratory for safe storage



Appendix 3. Terms and expressions

Term or expression	Explanation
ACDP	Advisory Committee for Dangerous Pathogens which has assigned pathogens to hazard groups 1 - 4 (see below).
ACGM	Advisory Committee for Genetic Modification (but see SACGM (CU)).
Autoclave	A steam pressure device used for sterilising liquids and materials to render them safe for disposal. Autoclaves are also used for preparing materials for use.
Biological agents	Broad term for potentially infectious pathogens such as bacteria and viruses, including those genetically modified.
Class I	A type of MSC (see below): protects the operator only; open fronted; air drawn in via front opening.
Class II	A type of MSC (see below); protects both work and operator; open fronted, air drawn in via front provides operator protection; vertical internal air curtain protects the work.
Class III	A type of MSC (see below); fully closed with glove ports, the operator is segregated from the work by a solid barrier.
Clean air or laminar flow Cabinets	These are not safety cabinets and are designed to protect the work only. Air is HEPA filtered and passes over the work towards the operator.
Containment laboratories	Laboratories where potentially infectious agents are handled have been categorised by the ACDP into 4 increasing levels of containment. See each containment level for further descriptions.
Containment Level 1	Usually suitable for ACDP Hazard Group 1 organisms or ACGM Class 1 GMOs.
Containment Level 2	Usually suitable for ACDP Hazard Group 2 organisms or ACGM Class 2 GMOs; criteria and selection are described in the COSHH and GMO (Contained Use) Regulations.
Containment Level 3	Usually suitable for ACDP Hazard Group 3 organisms or ACGM Class 3 GMOs; criteria and selection are described in the COSHH and GMO (Contained Use) Regulations.
Containment Level 4	Usually suitable for ACDP Hazard Group 4 organisms or ACGM Class 4 GMOs; criteria and selection are described in the COSHH and GMO (Contained Use) Regulations.
Containment tests	Tests designed to prove an MSC meets the BS EN Standard containment requirement. The most common test is the "KI discus" test using a generated mist of potassium iodide. Contractors carry these out as part of the regular servicing schedule.

Term or expression	Explanation
Hazard Group 1	Unlikely to cause human disease.
Hazard Group 2	Can cause human disease and may be a hazard to employees; it is unlikely to spread to the community and there is usually effective prophylaxis or treatment available.
Hazard Group 3	Can cause severe human disease and may be a serious hazard to employees; it may spread to the community, but there is usually effective prophylaxis or treatment available.
Hazard Group 4	Causes severe human disease and is a serious hazard to employees; it is likely to spread to the community and there is usually no effective prophylaxis or treatment available.
The Defra classification Group 1	Disease-producing organisms which are enzootic (native in animal in this country) and do not produce notifiable disease.
The Defra classification Group 2	Disease producing organisms which are either exotic or produce notifiable disease, but have a low risk of spread from the laboratory.
The Defra classification Group 3	Disease producing organisms which are either exotic or produce notifiable disease and have a moderate risk of spread from the laboratory.
The Defra classification Group 4	Disease producing organisms which are either exotic or produce notifiable disease and have a high risk of spread from the laboratory.
Foot and Mouth Disease	Minimum Standards for working with Foot-and-Mouth Disease virus (Group 4).
Rabies	Special accommodation for Rabies and Rabies related viruses.
Arthropods	Accommodation for vectors or parasites.
HEPA filters	HEPA = High Efficiency Particulate Absorption. These filters when tested in accordance with BS3928 must have a penetration not exceeding 0.003% at the filters manufacturers design volumetric rate. They effectively render downstream air as near to sterile as possible.
Laminar flow	Air flow that has been conditioned so that it is in parallel layers.
MSC	Microbiological Safety Cabinet - A device for providing operator protection when working with potentially biologically hazardous material.
PPE	Personal Protective Equipment - i.e. lab coats, gloves.
Risk assessment	The process of identifying significant hazards and specifying the measures needed to eliminate or minimise exposure to a residual risk. All work should be subject to risk assessment.
SACGM(CU)	Scientific Advisor y Committee on Genetically Modified Organisms (Contained Use) - (formerly ACGM).
SOP	Standard Operating Procedure - Written protocols for frequently or regularly used methods that must be followed.
Sterilisation	Destroying all living organisms or agents (e.g. prions) that can cause infection.
Disinfection	The use of a chemical or process that reduces the amount of pathogenic organisms present.

Auditing a Containment level 3 laboratory

Auditing a CL3 or SAPO3 laboratory or facility consists of two main parts;

- An inspection of the premises itself and verification that all the engineering controls including microbiological safety cabinets have been maintained and serviced according to the COSHH (2002) as amended regulations.

- To confirm that those working in the laboratory or premises are competent to do so. In this respect competence combines experience, training and the necessary academic qualifications required for the task. In essence this requires a record that the person(s) fulfil the aforesaid requirements.

Inspection of the premises or laboratory

Engineering controls

COSHH (2002) as amended requires that all engineering controls within a CL3 laboratory or facility are serviced and maintained at least every 14 months or earlier should there be deterioration in performance. This includes the microbiological safety cabinets (MSC), the autoclave and the magnehelic pressure gauges sited at the entrance to the facility or laboratory. Should the facility have a BMS system controlling the pressure differential then this must also be checked. If the autoclave is sited outside of the laboratory then a letter from the HSE allowing the derogation should be available on request. Servicing and maintenance must be carried out by competent engineers normally provided by an outside contractor. Normally the CL3 laboratory will be closed prior to such a visit. All pathogens will be securely stored and the laboratory and its equipment made safe by disinfection or fumigation.. It is unusual for the whole laboratory to be fumigated unless the risk assessment determined this to be the case.

Standards for containment level 3 facilities

The maintenance engineer when servicing an MSC II will test the filter integrity and ensure that that operator protection factor for an open fronted cabinet is greater than or equal to 10^{-6}. Air flow and filter integrity will be tested for a class I cabinet 'filter and glove' and enclosure integrity will be checked during the servicing of a class III cabinet. Autoclaves will be checked both for safe use under the pressure regulations and validated for its efficiency to reach the appropriate temperature and pressure. It must be tested under load conditions. A visual inspection of the walls and ceiling will also be carried out although this should also be done on a more frequent basis such as monthly. The visual inspection will look for tell tale signs of streaks where the ceiling and wall meet which may indicate a breach in the containment. Where these are found then more careful checking using a smoke pencil should be carried out. Should a leak be found or suspected then the area must be sealed with suitable sealant. The effectiveness of the repair must be tested. Where pipes or electrical cables breach any walls then they must also be checked for integrity. This can be done using a smoke pencil as before.

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