



University of Toledo Safety and Health Department Laboratory Design Guidelines

For any new construction or renovation of laboratory areas, consider health, safety and regulatory compliance issues early in the design stage of the project. The following outlines some of these issues:

- Layout
- Furniture and Fixtures
- Storage
- Laboratory Ventilation
- Emergency Equipment
- Materials Handling
- Utilities
- Other
- Project Checklist
- Biosafety Laboratories

A. Layout

Laboratory space should be physically separate from personal desk space, meeting space and eating areas with a closable door. Workers should not have to go through a laboratory space where hazardous materials are used in order to exit from non-laboratory areas. Consider making visible separation between lab and non-lab space, for instance with different flooring.

Fire-rated hallway doors should have magnetic hold-open features, such that the door will close in the event of an alarm.

Doors to laboratories should not be fire-rated unless necessary.

Entryways should have provisions for mounting emergency information posters and other warning signage immediately outside the laboratory (e.g., on the door).

Each door from a hallway into a lab should have a view panel to prevent accidents from opening the door into a person on the other side and to allow individuals to see into the laboratory in case of an accident or injury.

Laboratory areas with autoclaves should have adequate room to allow access to the autoclave and clearance behind it for maintenance. There should also be adequate room for temporary storage of materials before and after processing. Autoclave drainage should be designed to prevent or minimize flooding and damage to the floor.

For laboratories using radioactive materials: (Consult with Radiation Safety)

Eating and drinking areas should be physically separate (closable door) and conveniently located.

Allow for security of laboratory and materials.

Consider designing the lab to allow separation of radioactive materials use from other laboratory activities.

B. Furniture and Fixtures

Work surfaces should be chemical resistant, smooth, and readily cleanable, such as chemical-grade Formica.

Work surfaces, including computer areas, should incorporate ergonomic features, such as adjustability, appropriate lighting and equipment layout.

Benchwork areas should have knee space to allow room for chairs near fixed instruments, equipment or for procedures requiring prolonged operation.

Handwashing sinks for particularly hazardous chemicals or biological agents may need hands free operation

Wet chemical laboratories and darkrooms should have solvent resistant coved flooring using sheet goods rather than tile, particularly in areas where fume hoods are located.

Do not install more sinks or cupsinks than are necessary. Unused sinks may develop dry traps, resulting in odor complaints.

Sink faucets and hose bibs that are intended for use with attached hoses are provided with back siphon prevention (vacuum break) devices.

C. Storage

Cabinets for chemical storage should be of solid, sturdy construction. Hardwood or metal shelving is preferred. Some may require ventilation.

Materials of construction should be carefully considered where corrosive materials will be stored, e.g., corrosive-resistant liners or trays on shelves, location away from copper fittings, etc.

Allow space within the building for any central chemical and biological or radioactive waste storage needs.

Wall shelving should have heavy-duty brackets and standards and should be attached to studs or solid blocking. For office spaces, bookcases are preferable to wall-mounted shelving.

Flammable liquid storage needs should be defined in advance so that the laboratory may have space for a suitable number of flammable storage cabinets.

Flammable liquid storage (Class 1 Flammables) is not allowed below grade or near a means of egress, per the Uniform Fire Code.

Flammable storage cabinets should not be vented unless there is a significant odor or vapor control concern.

Laboratories using corrosive liquids should have ample storage space low to the floor, preferably in low cabinets, such as under fume hoods.

Allow space for the variety of waste collection containers needed. Depending on the laboratory, these may include laboratory trash, broken glass, sharps, recyclable containers, used oil, medical waste, and/or radioactive waste.

Laboratories using compressed gases should have recessed areas for cylinder storage and be equipped with devices to secure cylinders in place.

All laboratories should have storage space for supplies and combustible materials, e.g., boxes of gloves, spill kits, boxes of centrifuge tubes, etc.

D. Laboratory Ventilation

Laboratory ventilation rates should meet ASHRAE standards and ensure 8-10 air changes per hour minimum for occupied spaces and 6 air changes per hour minimum when unoccupied.

Bypass style fume hoods should be used. Auxiliary air hoods should not be used.

Fume hoods should have recessed work surfaces to control spills.

Canopy hoods should not be installed unless approved by Safety and Health and the use of snorkel hoods, or duct drops may be acceptable in some situations.

The location of fume hoods, supply air vents, operable windows, laboratory furniture and pedestrian traffic should encourage horizontal, laminar flow of air into the face of the hood, perpendicular to the hood opening. Hoods should be placed away from doors and not where they would face each other across a narrow aisle.

Hoods may have a face velocity of ~100 linear feet per minute with the sash open to 18" or at its standard configuration (e.g., at the stopper height).

Each hood must have a continuous monitoring device, such as a magnehelic gauge. The device should display either air velocity or static pressure, rather than only an audible alarm.

Supply air vents should be placed away from or directed away from fume hoods and Biological Safety Cabinets to avoid interference. Air velocity caused by supply vents should not exceed 25 feet per minute at the face of the hood.

Noise from the fume hood should not exceed 65 dBA at the face of the hood.

Use hard ducting for the positive side of exhaust ducting for all internal (penthouse) fans to prevent contaminant leakage into work areas.

Fume hood exhaust ducts must not contain fire dampers.

Unless otherwise specified (e.g., clean rooms), air pressure in the laboratory should be negative with respect to the outer hallways and non-laboratory areas.

Consider the need for vented chemical storage areas or cabinets for chemicals with low odor thresholds.

Semi-conductor, Photovoltaic and other hazardous gases (e.g., silane, hydrogen fluoride, chlorine, etc.) must be placed in vented gas cabinets and utilize stainless steel or coated duct work when corrosive gasses are used.

Hoods for perchloric acid require stainless steel construction and a wash-down system and a dedicated, isolated fan.

Hoods requiring filters (such as those for some radioisotopes or biological materials) should be designed and located such that filters may be accessed and changed easily.

Provisions should be made for local exhaust of instruments, gas cabinets, vented storage cabinets or other operations requiring local ventilation.

Single vertical sliding sashes are preferred over horizontal or split sashes.

Debris screens should be placed in the ductwork leading from the hood.

E. Emergency Equipment

Laboratories using hazardous materials must have an eyewash and safety shower within 100 feet or 10 seconds travel time from the chemical use areas.

Drench hoses support, but do not replace, safety showers and eyewashes.

Eyewashes and safety showers should have plumbed drains and mixed/tepid water supplied. The preferred model is a eyewash mounted near a sink with an extendable hose that can also be operated in a hands-free mode from the counter top. Contact Safety and Health 419-530-3600.

Eyewashes and safety showers should be standardized at least within a laboratory building.

Flooring under safety showers should be slip-resistant.

Safety showers may have privacy curtains, particularly in large laboratories or teaching laboratories.

Fire extinguishers, safety showers and eyewashes should be conspicuously labeled, particularly if recessed.

Fire extinguishers appropriate for the chemicals and equipment in use should be placed near the entrance of each laboratory, mechanical and electrical room.

Some chemical operations (e.g., distillation hoods) may benefit from hood fire suppression systems.

Windowless laboratories and environmental chambers should have emergency lighting.

Alarm enunciator panels should be descriptive of the area where the alarm has activated.

F. Materials Handling

Loading docks should be equipped with dockboards and should have enough room to maneuver pallets safely.

Cryogenic liquid tanks should be placed in such a manner that their controls could not accidentally be manipulated and such that they may be secured to prevent unauthorized access.

Cryogenic liquid tanks should be placed away from below grade areas where dense vapors may collect and away from glass doors or windows.

Avoid using flooring options that do not respond well to cold or hot temperature extremes.

A phone should be placed near any loading area.

G. Utilities

Utility shut-off controls should be located outside the laboratory.

Laboratories should have an abundant number of electrical supply outlets to eliminate the need for extension cords and multi-plug adapters.

Electrical panels should be placed in an accessible area not likely to be obstructed.

Ground fault circuit interrupters should be installed near sinks and wet areas.

Environmental chambers where evacuation or other alarms cannot be heard should be equipped with strobe lighting or additional alarms.

Central vacuum systems must be protected, since they are vulnerable to contamination.

All vacuum lines should have cold traps or filters to prevent contamination.

Chilled water loops should be available for equipment in need of cooling. Loops help to avoid excessive wastewater.

LASER laboratories should have an emergency cut-off switch installed near the entrance of the laboratory to turn off the LASER remotely. Many lasers require water-cooling systems requiring ground-fault circuit interrupters. Lighted signage that clearly indicates that a LASER is being operated should be present at all entrances to the lab.

H. Other

Laboratories using highly toxic gases should be equipped with alarmed vapor sensors, preferably with automatic shutdown systems.

Gas lines from highly toxic gases should use coaxial tubing for double containment. They should be welded in a continuous fashion and compression fittings only utilized inside of gas cabinets or other containment devices.

Animal care and use areas must meet Association for Assessment and Accreditation of Laboratory Animal Care International standards.

Biosafety or containment labs must be designed in coordination with the office of Research and the Biosafety Officer.


NMR laboratories should be equipped with Oxygen sensors and emergency exhaust features in the event of magnet quenching

Nano-scale laboratories must be evaluated by Safety and Health please call 419-530-3600


Contact Heather [Heather Lorenz](#) or [Michael Valigosky](#) with questions.


Safety and Health Design Considerations Project Checklist

Chemical, Biological or Radioactive Material Use

	CHEMICAL TYPE	CONSIDERATION	SECTION
<input type="checkbox"/>	General	Solvent resistant covered flooring, epoxy or other sealed seam sheet flooring (Avoid use of individual 12 X 12 tile floors as they allow contamination in between and below tiles)	B
		Possibly need ventilated storage (chemical dependent)	C
		Solid, sturdy shelving for storage	C
		Space for chemical waste storage	C
		Plumbed, (tempered water mixing valve) conspicuously labeled eyewash and safety shower within 100 feet or 10 second traveling distance	E
		Fire extinguishers mounted near entrance of work or storage area and conspicuously labeled.	E
<input type="checkbox"/>		Flammable Liquids	Contact Safety and Health for amounts of flammable and combustible liquids that can be safely stored in laboratories.
	Storage NOT allowed below grade per NFPA		C
<input type="checkbox"/>	Corrosives	Storage in low cabinets or shelves	C
<input type="checkbox"/>	Perchloric Acid	Stainless steel hood with washdown system	D
<input type="checkbox"/>	Radioactive materials	Physically separated (i.e. door) eating and drinking areas	A
		Separate radioactive material areas from other areas	A
		Space for radioactive waste storage	C
<input type="checkbox"/>	Biological Agents	Handwashing sinks with hands free foot or electronic controls	B
		Space for infectious waste storage	C
<input type="checkbox"/>	Highly Toxic Chemicals	Handwashing sinks with elbow or electronic controls	B
<input type="checkbox"/>	Highly Toxic Gases	Vented (monitored) gas cabinet	D
		Coaxial tubing	H
		Alarmed vapor sensors	H

Equipment

	EQUIPMENT TYPE	CONSIDERATION	SECTION
<input type="checkbox"/>	Autoclave	Adequate space for use, maintenance and materials storage	A
		Drainage to minimize flooding	A
<input type="checkbox"/>	Fume Hood	Bypass style. No auxiliary air hoods.	D
		Located to minimize cross-drafts and turbulence	D
		Face velocity ~100 linear feet per minute	D
		Continuous monitoring device	D
		No fire dampers in exhaust ducts	D

	EQUIPMENT TYPE	CONSIDERATION	SECTION
		Debris screen	D
		Single vertical sash (horizontal consult Safety)	D
		Adequate space for use, maintenance and materials storage	D
<input type="checkbox"/>	Biosafety Cabinets (BSC)	Class IIAB3 cabinets recommended (recirculating HEPA filtering units)	D
		Class IIB2 ducted BSC's may be appropriate for some containment labs but only per approval of Safety and Health	
		<u>Under no circumstances will natural gas be plumbed in to Biosafety Cabinets.</u>	
<input type="checkbox"/>	Distillation Hood	Larger walk in hood fire suppression system (For ethanol distillation should use alcohol resistant foam as suppressant)	E
<input type="checkbox"/>	Environmental Chamber	Emergency lighting	E
		Visual or audible local alarm if regular alarm system cannot be heard inside the chamber	F
<input type="checkbox"/>	Cryogenic Liquid Tanks	Controls secured or located to prevent accidental opening	F
		Consider epoxy flooring over concrete to protect sheet goods	
		Not below grade or near glass doors or windows	F
<input type="checkbox"/>	LASERS	Ground-fault circuit interrupters near water-cooling systems	G
		Consider use of chilled water loop	G
		Carbon dioxide fire extinguishers, rather than dry chemical extinguishers	D
		Installation of Lighted "LASER" signage indicating that LASER is in use	
		Emergency cut-off switch at entrance wired to LASER shutter	G
		Installation of LASER curtains and use of non-reflective materials and window coverings	
<input type="checkbox"/>	Equipment needing cooling	Chilled water loops	G
<input type="checkbox"/>	Vacuum lines	Central systems should be protected from contamination and may be plumbed into BSC	G
		Cold traps or filters to prevent contamination	G

BIOSAFETY LABORATORIES

A. Scope

The design and construction of a facility that contributes to efficient and safe work with biohazardous materials is the goal of this chapter. Before a proposed biosafety containment laboratory can be effectively planned, a risk assessment determines the containment conditions that are required. Risk assessments, conducted on a case-by case basis, consider the biohazardous materials, the nature of the work, procedures involved, equipment needs, regulatory requirements, national guidelines, and SAFETY AND HEALTH requirements. The guidelines presented here are for general-use Biosafety Containment Levels 1, 2, and 3 for biological research laboratories. Containment facilities for animals, large-scale (≥ 10 liters) operations, clean rooms, US Department of Agriculture containment requirements, Food and Drug Administration (FDA) containment requirements, greenhouse and Biosafety Level 4 work (BSL 4) are beyond the scope of this Guide.

If vertebrate animals are involved in research with biohazardous materials, special precautions are required. Requirements will be specified on a case-by-case basis by Safety and Health personnel.

Note: Each Biosafety Level builds to the next, so everything required for BSL1 labs is in turn required for BSL2 Labs as well.

B. Basic Laboratory Design for Biosafety Level 1

1. Each laboratory shall have a sink for hand washing.
2. The laboratories shall be designed for easy cleaning.
3. Carpets and rugs shall not be used.
4. Bench tops shall be impervious to water, and resistant to acids, alkalis, organic solvents and moderate heat.
5. Approved and accepted methods for decontamination of infectious or regulated laboratory wastes shall be available (e.g., autoclave, chemical disinfection or other decontamination system approved by the Safety and Health Biosafety Officer (BSO) or designee).
6. The autoclave need not be in the actual laboratory room. Autoclave installations need to be ASME stamped and UL Listed.
7. Laboratory furniture shall be:
 - a) Sturdy.
 - b) Capable of supporting anticipated loads and uses.
 - c) Chairs should be covered with liquid-proof fabric and/or plastic and easily cleaned/decontaminated material.
 - d) Such that spaces between and under benches, cabinets or equipment shall be accessible for cleaning.
8. Windows shall be fixed and not operable.
9. Doors shall be lockable.
10. Laboratories should be designed in order to incorporate proper ergonomic conditions for the tasks to be performed within the facility.

C. Basic Laboratory Design for Biosafety Level 2

In addition to the requirements for a BSL 1 laboratory, the following are required:

1. Floors shall:
 - a) Have a slip-resistant, smooth, hard finish.
 - b) Be liquid-tight, monolithic/seamless or have welded seams.
 - c) Have recommended flooring material covered up wall four inches or have the cove-base installed to create a watertight seal to the floor.
2. Walls should be durable, washable, resistant to detergents/disinfectants, and use durable high-gloss acrylic or epoxy paint or equivalent.
3. Exposed corners and walls shall be protected from damage by carts.
4. Ceiling height shall provide a minimum of twelve inches of clearance above biological safety cabinets (BSC). The ceiling around the BSC shall be high enough to allow for thimble connection (or gas-tight valves for Class II Type B BSC). This also allows for certification and proper functioning of recirculating BSC's. If the laboratory has a sprinkler system, local fire codes may require eighteen inches or more clearance.
5. Doors shall:
 - a) Be self-closing and locking.
 - b) Have fire ratings as required.
 - c) Not be provided with any kind of hold-open device.
6. Wall/ceiling penetrations shall be kept to a minimum and sealed with fire retardant material.
7. An emergency eyewash and shower unit shall that comply with requirements of Chapter 4 of this Guide shall be provided.
8. Floor drains shall be allowed for autoclaves.
9. An ASME-stamped UL-listed autoclave shall be provided in close proximity to the laboratory. Autoclaves shall be seismically anchored.
10. Venting of the autoclave is recommended; use manufacturer's recommended and good industrial ventilation design principles.

D. Basic Laboratory Design for Biosafety Level 3

The Biosafety Officer on behalf of and in accordance with the Institutional Biosafety Committee and their policies, must approve the location and design of any BSL 3 facility and has final authority to authorize commencement of BSL 3 work.

1. The design shall incorporate the following:
 - a) The facility must have effectively gas-tight walls, ceilings and floors (i.e., capable of containing decontamination gas during the decontamination process for a given period of time, according to Safety and Health specifications).
 - b) The air balance shall be set so air flows from low-hazard rooms to higher-hazard rooms.
 - c) Room construction shall be high quality with special consideration given to joints, finishes and penetrations.
 - d) Work surfaces, floors, walls and ceilings shall be designed, constructed, and finished to facilitate easy cleaning and decontamination.
 - e) Enhanced Security shall be provided as specified in following Item 25.
2. All tall and/or heavy fixtures and equipment (e.g., biological safety cabinets, autoclaves, etc.) should be fitted with a seismic anchoring system/device.

3. A third party owner's agent selected by Environmental Health and Safety familiar with BSL-3 design shall commission the facility. Commissioning shall include visual inspection and performance testing to verify that design and operational parameters have been met before research may begin. The commissioning plan shall be reviewed and approved by Safety and Health. Completed inspection and test reports and other documentation associated with commissioning shall be provided to Safety and Health.
4. The facility shall be located:
 - a) Away from public areas.
 - b) Separated from unrestricted traffic.
 - c) Such that entry to the laboratory is always via anteroom/change room.
 - d) So as to avoid entry into anterooms from the outdoors (with consequent dirt and contamination problems).
5. The anteroom shall:
 - a) Include access to the laboratory through two doors in series.
 - b) Be positively pressurized when compared to the BSL 3 facility but negative to the corridor.
 - c) Include doors that are interlocked or alarmed so that only one door may be opened at a time (with emergency egress interlock override as required by local fire code).
 - d) Have supply and exhaust air ducted in the room.
 - e) Have airflow of at least fifty cfm into the anteroom from the access corridor.
 - f) Have a floor sink provided with a drain that is resistant to disinfectant materials.
 - g) Provide for cylinders of CO₂ and other plumbed specialty gases to be kept outside the BSL 3 facility and anteroom.
 - h) Provide for storage of clean gowns, laboratory coats or uniforms that must be donned before entry, and in addition to a place for used protective clothing that must be removed before leaving the suite.
 - i) Have communications capabilities installed.
 - j) Provide eight square feet of floor space provided for a laundry hamper.
 - k) Have Autoclave and exhaust canopies.
6. Floors shall be:
 - a) Liquid-tight, monolithic/seamless or with welded seams.
 - b) Coved up the wall four inches.
 - c) Easily cleaned, chemical-resistant flooring with a slip-resistant, smooth, hard finish.
7. Walls shall be:
 - a) Washable, easily cleaned, and resistant to detergents/disinfectants (i.e. high gloss acrylic or epoxy paint, or equivalent).
 - b) Extending to the structural deck above (full height).
 - c) Protected from damage by carts, etc., where corners and walls are exposed.
8. The ceiling shall:
 - a) Be washable, resistant to detergents/disinfectants.
 - b) Be covered with durable high-gloss acrylic or epoxy paint or equivalent.
 - c) Be of monolithic construction (i.e., gypsum board, permanently affixed tiles).
 - d) Have airtight access panels, if any.
9. At least twelve inches of clearance above biosafety cabinets that exhaust directly into the laboratory shall be provided per NSF-49. When fire sprinklers are installed, a greater clearance may be required by local fire codes.

10. When a thimble connection is used (Class II A2 BSC) the ceiling height must accommodate the biosafety cabinet, thimble and duct.
11. Doors shall:
 - a) Be self-closing and locking (see Item 24, "Security Systems").
 - b) Open inward.
 - c) Be of solid-finish construction, including the doorframe.
 - d) Have openings large enough to allow passage of large equipment.
 - e) Have doorframe connections to the wall be made airtight at time of frame installation.
 - f) Relites are recommended.
12. Windows shall:
 - a) Be installed in an airtight manner.
 - b) Be safety glass, permanently closed and silicone sealed.
 - c) In addition, windows should be installed which permit viewing, communication, and supervision.
13. Viewing into the BSL 3 facility is not allowed from public areas.
14. Plumbing shall have:
 - a) All penetrations perpendicular to the surface and shall be caulked to be gas-tight.
 - b) All pipes into the BSL 3 facility secured to prevent movement.
 - c) Corrosion-resistant fixtures (specifically bleach and other disinfectants).
 - d) Space and connections provided so CO₂ and other specialty gases are stored outside the containment laboratory and/or vivaria and therefore shall be piped in.
 - e) Back-flow prevention provided on all faucets (including industrial water).
 - f) Piping properly identified by use of labels and tags.
 - g) Flexible gas and vacuum connections.
 - h) In addition, a floor sink in anteroom and the location of the water supply control outside the biocontainment area are also recommended.
15. Hand-washing sinks shall:
 - a) Be located in each room near the exit.
 - b) Dispense potable water.
 - c) Be either hands-free or automatically operated.
 - d) Be near a wall-mounted paper towel dispenser and a wall-mounted soap dispenser.
 - e) In addition, the following are recommended:
 - Have hot and cold water from a pre-mixing faucet.
 - Have an oversized, backsplash coved at the base to facilitate cleaning.
16. An emergency eyewash shall be located in each BSL 3 room, and an emergency shower, that complies with Chapter 4 of this Guide shall be provided.
17. A HEPA filter and disinfection traps shall be installed on vacuum system lines before they leave the BSL 3 facility. A HEPA filter shall be installed in-line before the pump when vacuum pumps are in the BSL 3 facility.
18. Electrical systems and communications systems networks shall:
 - a) Keep wall/ceiling penetrations to a minimum and be sealed with fire retardant material (i.e., 3M CP-25 or equal).
 - b) Not compromise the airtight quality of the facility.
 - c) In addition, the following are recommended:
 - Junction boxes that are cast and/or sealed airtight.

- Surface-mounted light fixtures or light fixtures designed to maintain the facility's gas-tight requirements.
 - Independent circuits for each biosafety cabinet.
 - Circuit breakers located outside biocontainment area.
 - Standby emergency power provided for essential equipment,
19. An autoclave shall be available in the BSL 3 facility with pass-through to the anteroom or support area. Autoclaves may be located outside the BSL 3 facility but within the building when approved by Safety and Health. The autoclave installation shall also have:
- a) Bioseals or other equivalent means to create a seal at the wall.
 - b) Floor penetrations, if essential, which are sealed at the monolithic floor to be water- and gas-tight.
 - c) Sign-off by a professional engineer.
 - d) Autoclave repair access outside the containment zone.
 - e) Insulated pipes if exposed.
 - f) Seismic anchoring for autoclaves.
 - g) In addition, the following are recommended:
 - Verification with users as to the size and need for microisolator cycles.
 - An integral effluent decontamination system for discharge.
 - A corrosion-resistant basin, which prevents leakage.
 - A canopy hood over the autoclave to capture and remove heat and steam from each end of the autoclave.
20. Heating, Ventilation, and Air Conditioning (HVAC) systems shall meet the requirements of section 4 of this Guide. In addition, they shall:
- a) Create directional airflow drawing air from low-hazard rooms/areas to higher-hazard rooms/areas.
 - b) Use supply and exhaust dampers of gas-tight design and closable from outside the facility to facilitate decontamination.
 - c) Be balanced so that the minimum pressure differential between the hallway and anteroom is 0.05 inches of water and the minimum pressure differential between the anteroom and the laboratory is another 0.05 inches of water.
 - d) Be provided with alarm panels with pressure indication between the laboratory and anteroom, and anteroom and hallway. These panels shall have visual and audible alarms to warn of failure in differential pressure inside and outside the containment module.
 - e) Provide air supply and exhaust system capacity, which is $\geq 125\%$ of the laboratory's requirements. The use of a redundant fan system is optional.
 - f) Not become positively pressurized if the exhaust system fails. The supply and exhaust fans should be electrically interlocked.
 - g) Monitor pressure gradients in this area.
 - h) Maintain negative air pressure by providing 10% more exhaust airflow air than supply air.
 - i) Rooms of higher hazard shall have ≥ 50 cfm flowing into them from lower-hazard rooms.
 - j) Provide an air balance, which accommodates BSC thimble exhaust requirements if Class II A2 cabinets are used.
 - k) Be provided with a damper in the HVAC bypass if Class II B1 or B2 cabinets are used. This damper shall be interlocked with the BSC to exhaust the laboratory when the BSC is turned off (extends filter life, assures negative

- pressure is maintained within the laboratory and provides room ventilation during BSC or laboratory decontamination).
21. HEPA filters, if provided on the exhaust system, shall be either **bag-in/bag-out** or capable of isolation (by gas-tight damper) to accommodate gas decontamination. Provisions shall be made to replace gas-decontaminated filters after decontamination when the decontaminant is incompatible with HEPA filter media (e.g., aqueous solutions that will weaken filter media or substances that will corrode or degrade the filter media).
 - a) Exhaust-system HEPA filters shall be provided for BSL 3 facilities. HEPA filters should comply with DOE-STD-3020-97 (or the latest edition).
 - b) Arrangements shall be made to permit periodic leak testing of exhaust-system HEPA filters. The system design should comply with ASME AG-1. The test arrangement shall have these features:
 - An injection port or location located upstream of the HEPA filter to accommodate DOP (or equivalent) challenge aerosol testing. This location will promote uniform mixing of the challenge aerosol with subsequent turbulence.
 - An upstream sampling port installed about six to twelve inches upstream from the filter.
 - A downstream sampling port located where the airflow has become thoroughly mixed. This may be accomplished using a Stairmand disk located four to six duct diameters downstream, a downstream leak-tight fan, or similar arrangements.
 - Penetrations of a design that can be plugged or capped between leakage tests.
 - Alternatively, commercially fabricated bag-in/bag-out assemblies with factory-installed equipment for injection, mixing, and sampling of challenge aerosols may be used.
 - c) A magnahelic gauge or other pressure-monitoring device shall be installed to measure pressure drop across all HEPA filters. The magnahelic gauges or pressure-monitoring devices shall be readable from outside the BSL 3 facility.
 22. Space shall be provided on or near the door for the conspicuous posting of:
 - a) The biohazard warning symbol.
 - b) A list of personnel authorized, possibly by title, to enter the area.
 - c) Access rules.
 23. Security systems shall be used to control access to the building and/or region of the building and the BSL 3 laboratory. The security system shall limit access to authorized people, and record entry and exit times and dates. Security measures shall equal or exceed the guidance set forth in Appendix F of the latest version of the CDC-NIH "Biosafety in Microbiological and Biomedical Laboratories". Please contact the Biosafety Officer for security and access control equipment and requirements.
 24. A telephone communications network and/or intercom system shall be installed so workers can communicate with people outside the BSL 3 in the event of emergency or for business reasons.
 - a) The telecommunications and computer systems shall not reduce the airtight integrity of the facility.
 - b) Wall/ceiling penetrations shall be kept to a minimum and sealed with fire retardant material.
 - c) A hands-free phone with foot or knee-operated pickup is recommended.

25. A “pass-through” (for supplies, product or equipment) shall be approved by the Biosafety Officer on a case-by-case basis.

E. Biological Safety Cabinets and Other Containment Considerations

1. Biological safety cabinets shall be located away from doors, high-traffic, ventilation diffusers and other air current sources.

NSF Standard 49, Annex E

Air turbulence is generated (room air pressure is also affected) when doors are opened and when people walk in the vicinity of the biosafety cabinet. Currents of air can disrupt the protective capability of the cabinet. Installing biosafety cabinets in low traffic areas minimizes this problem.

2. Two biosafety cabinets should not be installed directly opposite each other when they are closer than six feet apart.

Good Practice

Laminar airflow is greatly hindered by the concurrent operation of two biosafety cabinets situated across from each other. The potential for air turbulence also increases when two cabinet operators are working at the same time in the same immediate vicinity.

3. Do not design BSCs to be plumbed with natural gas; this is prohibited.
4. Biological Safety Cabinets (BSC) shall be installed as follows:
 - a) Class II, Type A2 BSC for biohazard work not involving chemicals; they shall be connected to the exhaust system via an air gap (thimble connection).
 - b) With thimble connections as provided by the BSC manufacturer or as approved by the Biosafety Officer.
 - c) Class II, Type B2 BSC for biohazardous work involving flammable, volatile, and toxic chemicals and radionuclides. Class II Type B2 BSC shall be directly (hard) connected to a dedicated exhaust system.
 - d) Class II B BSC shall be interlocked with the exhaust fan so they shut down and alarm in the event of an exhaust fan/system failure.
 - e) Class II B1 and B2 BSC shall be provided with a gas-tight valve for decontamination on the exhaust that is accessible from the front or side of the cabinet.
 - f) Class II B1 and B2 BSC shall not share a common HVAC manifold or fan; separate ducts and fans shall be provided.
 - g) Thimble connection exhaust airflow shall be 120-125% of the BSC manufacturer's exhaust specification.
 - h) In addition, BSC in BSL 3 facilities should:
 - Have at least twelve inches of clearance is provided above it for testing and decontamination of HEPA filters.
 - Have at least four inches of clearance from the rear and six inches' clearance on the utility side of the cabinet.
 - Have the power receptacle located high on the wall so the unit may be easily unplugged for servicing.
 - Be ergonomically designed.
 - Be seismically anchored.
 - Have utilities lines installed behind it.
5. All cabinets shall be NSF listed, UL approved and installed in accordance with the manufacturer's requirements.

Good Practice

The cabinet manufacturer has designed a unit which, when used and installed properly, will provide both product and personnel protection. However, if the cabinet is not installed properly (i.e., not ducting a Class II B2 cabinet), then it will not be serviceable. To install a cabinet and deviate from the listed NSF requirements will void the NSF Standard 49 approved listing.

6. When initially installed or when reinstalled, biosafety cabinets shall be provided with an appropriate means of seismic stabilization.

Good Practice

NOTE: The manufacturer should always be consulted to avoid possible damage to the pressurized cabinet volumes.

7. Biosafety cabinets shall be certified by Safety and Health technicians prior to building acceptance or, for installations not involving significance building modifications, before use with biohazards.

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Good Practice

8. Class II Type A BSC shall be vented from the building through a thimble connection unless specifically exempted by Safety and Health. Researchers must confer with the Biosafety Officer and provide information regarding materials and agents to be used in the cabinet. Exemptions will not be considered when information is not provided or unavailable

Good Practice

9. Where BSC are connected to external ducts, a flow monitoring system with audible and visual annunciations shall be used to alert the BSC of loss of external ventilation. Alternatively, thimble connections or canopy mini-enclosures in BSC shall be fitted with a ribbon streamer or equivalent attached at an edge through which air enters the device to indicate the airflow direction.

10. Security measures shall be designed and installed to meet or exceed the conditions set in Appendix F "Laboratory Security: an Emergency Response for Microbiological and Biomedical Laboratories." *CDC-NIH Biosafety in Microbiological and Biomedical Laboratories*

11. The Biosafety Officer must approve The BSC make and model prior to procurement.