

UMassAmherst

Environmental Health & Safety

UMass Amherst Lab Design Guidelines

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I. Contents

II. Scope and Purpose.....	3
III. Authorities and Standards	3
IV. General Planning and Design of Areas That Use Hazardous Materials or Processes	4
V. Chemical Storage	5
VI. Ventilation.....	5
A. Fume Hoods	6
B. Biosafety Cabinets.....	7
C. Snorkels.....	8
D. Canopies.....	8
E. Equipment Requiring Exhaust.....	8
F. Exhaust Filtering and Scrubbing Units	8
VII. Emergency Equipment.....	9
A. Drench Showers	9
B. Eye Washes	9
C. Fire Extinguishers	10
D. Sensors and Alarms.....	10
VIII. Lasers	10
IX. Other Specialty Labs.....	11

II. Scope and Purpose

UMass Amherst expects architects, engineers, and designers to construct campus buildings and spaces that meet building codes and regulatory standards and also provide a safe and healthy environment for occupants and maintenance personnel. This manual provides some additional background on certain design requirements that relate to environmental, health and safety (EH&S) issues for laboratory, shop, and studio spaces. This manual does not address, and is not intended to nullify or assume responsibility for, the architect's duty to know and understand all governing requirements in accordance with their executed agreement with the University. Rather, it is provided solely to communicate certain EH&S design issues that may be overlooked by architects and their consultants during the design of a University project. It also should be understood that this manual is a basic guide. In all cases, the project team must involve EH&S in all phases of the project from programming through occupancy. Decisions about the need for and selection of safety features such as local exhaust ventilation, eye wash stations, etc. must be reached in consultation with EH&S. Any changes to agreed safety features must be reviewed by EH&S.

III. Authorities and Standards

The following are the basis for the provisions included in this guide.

- ANSI/ASHRAE 110-2016: <https://webstore.ansi.org/standards/ashrae/ansiashraestandard1102016>
- ANSI/ASHRAE 62.1-2022: <https://www.ashrae.org/technical-resources/bookstore/standards-62-1-62-2>
- ANSI/ASSP Z9.5-2022: <https://webstore.ansi.org/standards/asse/ansiasspz92022?source=blog>
- Biosafety in Microbiological and Biomedical Laboratories (BMBL), 6th edition: <https://www.cdc.gov/labs/BMBL.html>
- International Mechanical Code (IMC 2021): <https://codes.iccsafe.org/content/IMC2021P1>
- Massachusetts Building Code (780 CMR): <https://www.mass.gov/massachusetts-state-building-code-780-cmr>
- Massachusetts Fire Code (527 CMR 1): <https://www.mass.gov/service-details/massachusetts-fire-code>
- Massachusetts Laser Regulations (105 CMR 121): <https://www.mass.gov/regulations/105-CMR-12100-to-control-the-radiation-hazards-of-lasers-laser-systems-and-optical-fiber-communication-systems-utilizing-laser-diode-or-light-emitting-diode-sources>
- Massachusetts Plumbing Code (248 CMR 10): <https://www.mass.gov/regulations/248-CMR-1000-uniform-state-plumbing-code>
- NFPA 45-2019: <https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=45>
- NFPA 55-2023: <https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=55>
- NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines), 2019: <https://osp.od.nih.gov/policies/biosafety-and-biosecurity-policy#tab2/>
- NSF/ANSI 49-2020: <https://webstore.ansi.org/standards/nsf/nsfansi492020?source=blog>

- OSHA Laboratory Standard (29 CFR 1910.1450): <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1450>
- UMass Amherst Laboratory Health and Safety Manual/Chemical Hygiene Plan: <https://ehs.umass.edu/laboratory-health-and-safety-manualchemical-hygiene-plan>
- UMass Biosafety Manual: <https://ehs.umass.edu/biosafety-manual>
- UMass Laser Safety Manual: <https://ehs.umass.edu/laser-safety-manual>
- UMass Shop Policy: <https://ehs.umass.edu/shop-safety-policy>

IV. General Planning and Design of Areas That Use Hazardous Materials or Processes

The following items are generally applicable to labs, shops, studios, or other similar areas where hazardous materials or processes are used.

- Labs should be designed to be as flexible as possible. Modular benches and cabinets are preferred where possible. Additional supply and exhaust capacity and functional connections for additional local exhaust ventilation should be incorporated where feasible.
- Labs must be able to be locked with respect to public spaces.
- For areas with highly hazardous operations (including BSL-2 containment) or materials, desks for lab personnel must be located outside of the lab area. When possible, desks for lab personnel should be located outside of the lab area even for lower hazard operations or materials. When desks are included in the lab space, a clear division must exist between the desk and work areas and may necessitate the use of an appropriate barrier.
- Chairs and other furniture in labs must not include fabric and must be washable.
- Control areas in buildings should be appropriate for current and foreseeable future planned use. Labs that use or plan to use toxic gases, or other materials that could create code limit issues, should be located on grade floors.
- If floor drains are existing, they should be left in place in lab renovations. For new buildings, self-priming floor drains should be installed in labs where flooding is likely or where drench showers or autoclaves are present. Floor drains are not required to be installed in existing buildings that do not already have floor drains unless the drain is needed for an autoclave or other specific piece of equipment.
- All new lab areas must have sprinklers, and sprinkler installation should be included for lab renovations where these do not already exist. Sprinkler heads and heat and smoke detectors must be at least 18" away from items on shelves, equipment, or other obstructions.
- Lab areas should not have operable windows. If labs with operable windows are renovated, operable windows should be either replaced with non-operable windows or the existing windows sealed to not open.
- Door widths are recommended to be at least 42" to accommodate equipment that may need to be brought in to labs. Doors to public areas or research areas requiring separation must be equipped with door closers. Doors should swing in the direction of egress where permitted by code.

- Access panels in labs should be placed in locations that will minimize disruption to lab activities in the event that access is needed while the lab is occupied. Placement of electrical panels and other access areas should be such that these will not be obstructed by equipment.
- Ensure there is at least 5' of aisle space between benches.
- An 8.5"x11" sign holder should be provided by every door entry and by all emergency eye wash areas for required signage.
- Occupancy sensors in lab areas must be positioned such that every area of the room can be sensed.
- At least one sink is required in all lab areas separated by public areas for hand washing. Soil/sediment traps should be installed on sinks in labs that will be processing soil and rocks or other rinsing operations that could potentially clog drains.
- Materials used for benches, floors, bases of fume hoods, cabinets, walls, and other areas should be appropriate to the hazards and processes (including cryogen use) planned for the space. Surfaces should be easy to clean. Seamless floors extending 6" up walls and cabinet bases are recommended with grit for traction.
- The project should obtain a current and planned equipment list for each lab, and all equipment must be installed according to manufacturer's specifications, including all services (such as hazardous exhaust connections) that are specified.
- No natural gas or propane should be plumbed to any areas in the lab, including benches and biosafety cabinets.

V. Chemical Storage

- Chemical storage must not be located more than 6' above the floor.
- Flammable storage cabinets located under fume hoods should be ventilated directly to the hazardous exhaust stream (i.e., not simply an opening to the base of the fume hood) and must be equipped with flame arrestors. Flammable storage cabinets under hoods do not need to be ventilated, though it is preferred. If cabinets are not ventilated, bungs must be in place in openings to ensure appropriate fire resistance rating.
- Corrosive storage cabinets located under fume hoods must be of plastic only construction on the interior (i.e., no metal hinges or screws) and may be ventilated to the base of the fume hood, provided this is an approved configuration by the fume hood manufacturer. Corrosive storage cabinets under hoods do not need to be ventilated, though it is preferred.
- Gas cylinder brackets should be installed where gas cylinders are in use. Inert gases may be plumbed through appropriate connections throughout the lab space. Oxidizing, flammable, and higher hazard gases must be located as close to the point of use as is feasible. (Note that gas cabinets and specialized connections may be required for higher hazard or flammable gases; consult with EH&S.)

VI. Ventilation

- Decisions about the need for and specification of local exhaust ventilation (i.e., fume hoods, biosafety cabinets, snorkels, canopies, etc.) must be reached in consultation with EH&S. It is not appropriate for the project alone to determine what type of local exhaust ventilation is required for particular applications.

- All labs must be negatively pressurized with respect to surrounding public areas. An offset of 100 cfm is generally acceptable. More may be necessary for higher hazard or specific areas. Consult with EH&S.
- Exhaust air from local exhaust ventilation devices in labs may not be recirculated to other parts of the building. Fan coil units, chilled beams, mini-splits and other recirculating units are appropriate to use in lower hazard labs for additional thermal control in individual lab units when needed. General room exhaust from a lab may only be recirculated to other parts of the building if approved by both EH&S and the Authority Having Jurisdiction (AHJ) and must be determined on a case by case basis.
- Duct work for hazardous exhaust must be appropriate to the types of materials present in the exhaust stream (as determined by consultation with EH&S) and as approved by the sheet metal inspector. Duct work must not be positively pressurized in occupied spaces.
- Fans for hazardous exhaust systems should be placed on roofs and must not be in occupied spaces. If exhaust fans are located in a penthouse or mechanical room, the area must be under negative pressure with respect to the occupied areas of the building. Booster fans in occupied spaces are only permitted with approval by EH&S.
- Fans for hazardous exhaust systems should be connected to emergency power whenever possible. Dampers that close in the event of fan failure are not permitted, with the exception of BSL-3 areas.
- Supply air should be filtered to an appropriate level for the use of the lab space. Other treatment, such as electrostatic precipitation, is not permissible without consultation with EH&S.
- Supply air diffusers should be located as far away from fume hoods and biosafety cabinets as is feasible. Supply air diffusers should be angled to blow away from the opening of fume hoods and biosafety cabinets and should have a velocity of no more than 25 fpm (or 30% of the designed face velocity) at occupant level. Perforated diffusers are preferred when possible.
- General exhaust (when needed for balance) should be supplied through openings operate at velocities of no more than 750 fpm and must be located away from fume hoods and biosafety cabinets.

A. Fume Hoods

- Ductless fume hoods (i.e., filtering fume hoods) are not permissible unless approved by EH&S for very specific and limited applications.
- Fume hoods should be manifolded when possible to allow for fan redundancy.
- Fume hoods should not be positioned face-to-face (offset across 5' aisles is fine), near doors (at least 10' of distance is recommended), in high traffic areas, immediately next to each other (at least 24" distance should be provided), or immediately next to walls (at least 4" distance should be provided).
- All fume hoods installed in labs should be variable air volume (VAV) and designed to operate at a face velocity of 80 fpm \pm 10% at sash operating height unless otherwise specified and agreed upon by EH&S. Labs with higher hazard operations may require face velocities up to 100 fpm and/or constant volume fume hoods. If face velocities less than 80 fpm are agreed to, the project should plan for exhaust/supply capacity sufficient to run fume hoods at 80 fpm should the hoods fail the ASHRAE 110 test (see below) at lower face velocities.

- All fume hoods must be equipped with a calibrated flow meter that will go into alarm (audio and visual) when the face velocity of the hood deviates by more than 20% of design specification at sash operating height. Devices that measure actual air flow or differential pressure are required; sash sensors alone are not adequate.
- New fume hoods must be equipped with a purge button allowing for increased air flow through the hood in the event of a spill. Rooms with larger amounts of hazardous materials or higher hazard operations (as determined by review of EH&S) should also be equipped with a room purge button.
- Vertical and vertical/horizontal (i.e., combination) sashes are both permissible and selection should be as determined by the users' preference.
- The number and capacity of outlets at fume hoods should be appropriate to the planned equipment use in the hood. Use of two or more hotplates at a time in a single hood frequently requires higher capacity circuits. GFCI outlets are required in fume hoods.
- Automatic sash closers can only be used if desired by the occupants and if agreed upon with EH&S.
- All fume hoods installed in labs must pass the ASHRAE 110-2016 test after testing, adjusting and balancing (TAB) of the ventilation system is complete and any problems that could affect overall balance or fume hood performance addressed. Please note that TAB should only be completed with all ceiling tiles in place, doors to the labs closed, adequate temperature control, mechanical systems operating properly and to design, and all other items that could impact air flow and balance in place. The same is true for the conditions of the ASHRAE test. Fume hoods in teaching labs or other higher traffic areas must additionally pass the dynamic portion of the NIH-modified ASHRAE 110-2016 test as specified by EH&S. EH&S must be informed by the project of when the testing is scheduled for. It is the responsibility of the project to schedule and pay for the ASHRAE test. You may contact EH&S at askehs@umass.edu for a current list of preferred providers.

B. Biosafety Cabinets

- Biosafety cabinets (BSCs) are required in areas with work requiring BSL-2 containment or as otherwise determined by EH&S.
- Class II A2 biosafety cabinets (recirculating units that afford protection to the work surface and the user) should be selected. Class II A1 cabinets may be used with approval from EH&S for specific low hazard applications, if desired. Laminar flow devices that push air over the work surface toward the user (sometimes called "clean benches") do not afford protection to the user, and are therefore not acceptable unless specified for particular applications by EH&S. Class II B1 and B2 biosafety cabinets (ducted) should not be installed unless specified by EH&S as these consume large amounts of energy.
- Biosafety cabinets selected for purchase should not contain UV sterilization capability.
- Gas (propane or LNG) must not be plumbed to biosafety cabinets.
- Any outlets on the cabinet must be GFCI.
- Biosafety cabinets should not be positioned face-to-face (offset across 5' aisles is fine, 10' is required if face-to-face), near doors (at least 10' of distance is recommended), in high traffic areas, immediately next to each other (at least 40" distance should be provided), or immediately

next to walls (at least 12" distance should be provided). At least 14" of clearance must be provided above the cabinet to allow for annual recertification and proper functioning.

- All biosafety cabinets must pass the NSF/ANSI 49-2020 certification test prior to use. Anytime a biosafety cabinet is moved, the test is required. Used biosafety cabinets also must be appropriately decontaminated before removing from labs; consult EH&S. It is the department's or project's responsibility to schedule and pay for the testing and any necessary decontamination. You may contact EH&S at askehs@umass.edu for a current list of preferred providers.

C. Snorkels

Snorkels are of limited use in labs and do not take the place of fume hoods, direct exhaust connections for equipment, canopies to remove heat, or other specific local exhaust ventilation. Use of snorkels for specific applications must be discussed with and approved by EH&S (including volumetric flow rate requirements). Appropriate applications can include:

- Soldering
- Welding (with specially designed and selected units)
- Low hazard activities that can be conducted while having the opening of the snorkel no more than one duct diameter away from the point of generation of airborne material.

D. Canopies

Canopies are best used for hot processes that are low hazard in nature and that do not require the user's head to be in between the source of hazard and the canopy exhaust. Canopies do not take the place of fume hoods, direct exhaust connections for equipment, or other specific local exhaust ventilation. Use of canopies for specific applications must be discussed with and approved by EH&S (including volumetric flow rate requirements). Appropriate applications can include:

- Autoclaves
- Ovens and furnaces
- Particular types of welding

Canopies must completely cover the area over the source of emission and must extend at least 3" past the area on all sides.

E. Equipment Requiring Exhaust

All equipment must be installed according to manufacturer's recommendations. If direct exhaust connection is specified for existing or planned equipment, this must be covered in the scope of the project. Appropriate connections should be made for existing equipment, and appropriate capacity and connection should be provided for planned equipment that will be installed at a later date.

F. Exhaust Filtering and Scrubbing Units

Where specified by the manufacturer and approved by EH&S, stand-alone filtering/scrubbing units (such as fume extractors and dust collectors) may be used for specific equipment and applications in lieu of local exhaust ventilation. The appropriateness of this must be determined on a case by case basis. Consult with EH&S.

VII. Emergency Equipment

The extent and type of emergency equipment present and required in a space depends on the usage of the space and code requirements. Requirements for typical items are covered here. Consult with EH&S for more specialized situations.

A. Drench Showers

- Drench showers are required in all areas that use corrosive or flammable materials, have open flames, or store chemicals as specified by the MA plumbing code, or as otherwise specified by EH&S.
- All points of use of hazardous materials in a lab must have a drench shower located within 50' of path travelled to reach the drench shower from the point of use.
- If a door separates the drench shower from the point of use, the door must swing in the direction of the path of travel to the drench shower from the point of use. If this cannot be accomplished, an additional drench shower will be required on both sides of the door.
- Drench showers should be installed as close to the exit door as possible.
- Newly installed drench showers are required to have tempered water provided as per the MA plumbing code. If tempered water is not available, consult with EH&S to determine if requesting a variance is appropriate for specific situations.
- Floor drains are not required for drench shower installations in existing buildings without floor drains, however, they are encouraged. New buildings should incorporate floor drains for all drench showers.
- The project is responsible for coordinating with the plumbing inspector at the end of the project to perform testing necessary to demonstrate that the units comply with code parameters (including flow rates) to the satisfaction of the plumbing inspector. The project must supply the materials and labor necessary to perform this testing.

B. Eye Washes

- Combination eye washes/drench shower units are preferred.
- All eye washes should be plumbed to a drain. If this is not feasible based on existing building conditions, the drain outlet of the eyewash must be positioned such that a 5 gallon bucket is able to fit under the drain (i.e., at least 20" above the floor) and the drain outlet designed such that water easily flows into the bucket without extraneous splashing.
- Eye washes are required in all areas that use corrosive or flammable materials, have open flames, or store chemicals as specified by the MA plumbing code, or as otherwise specified by EH&S.
- All points of use of hazardous materials in a lab must have an eye wash located within 50' of path travelled to reach the eye wash from the point of use.
- If a door separates the eye wash from the point of use, the door must swing in the direction of the path of travel to the eye wash from the point of use. If this cannot be accomplished, an additional eye wash will be required on both sides of the door.
- Eye washes should be installed as close to the exit door as possible.
- Newly installed eye washes are required to have tempered water provided as per the MA plumbing code. If tempered water is not available, consult with EH&S to determine if requesting a variance is appropriate for specific situations.

- The project is responsible for coordinating with the plumbing inspector at the end of the project to perform testing necessary to demonstrate that the units comply with code parameters (including flow rates) to the satisfaction of the plumbing inspector. The project must supply the materials and labor necessary to perform this testing.

C. Fire Extinguishers

Type ABC fire extinguishers are required in and around lab areas at distances established by the fire code. Generally for lower hazard areas, 10 lbs. extinguishers are required no more than 50 ft. of travel distance from every work area in the lab. Please consult the fire code and the fire marshal for other situations. The fire extinguishers should be ordered by the project through EH&S. Contact the fire marshal to arrange.

D. Sensors and Alarms

Labs that use larger volumes of inert gases or cryogenics or that use toxic or reactive gases may need to be equipped with sensors and alarms that are tied in to the BAS. Please consult with EH&S to determine the need and specification for these systems.

VIII. Lasers

The MA laser regulations enforced by the Department of Public Health require adherence to the ANSI Z136.1 standard for the “Safe Use of Lasers”. The regulations also require that ultimate decisions about control measures used to protect users from laser beams be determined by the institution’s laser safety officer in EH&S since the appropriate control measures are a function of how the laser is used. Below are some guidelines that should generally be followed for all labs that will contain class 3B or 4 lasers. Specific measures must be reached in consultation with EH&S.

- Class 3B and 4 laser beams must be fully enclosed in protective housing, whenever possible. When this housing is not part of an instrument with interlocks or removable panels, it would usually necessitate the use of an appropriately rated laser safety curtain with interlocks. The interlocks can either trigger a beam block to isolate the beam or terminate power to the laser in the event of removal or breach of housing during laser operation. Beam blocks are typically preferred by researchers to protect the laser. Any area of the housing that is designed to be removed or displaced is required to be interlocked.
- Laser curtains must be rated for the power and wavelength of the laser. Kentek is a preferred vendor. Discuss other options with EH&S. Laser curtains must fully enclose beam hazards.
- If the class 3B or 4 laser beam cannot be fully enclosed at all times by interlocked protective housing, additional control measures are required as determined by a hazard analysis performed by EH&S, and may include:
 - Blocking windows to other areas with appropriate material or removing windows
 - Creating a protected entry area with a laser curtain or protective barrier and interlocks
 - “Laser in Use” light visible prior to entry into the room that is electrically interfaced with the laser
 - Controlled access to the laser area.
- The project is responsible for providing the selected control measures that are necessary for safe and compliant use of existing or planned lasers in the space.

IX. Other Specialty Labs

Other specialty labs have requirements beyond the scope of this document and require extensive consultation and involvement of EH&S. These include, but are not limited to:

- A/BSL-3 areas
- Cleanrooms
- Vivaria
- Labs that use highly hazardous materials
- Shops which are defined as: any designated area where hazardous tools and machinery are used for fabricating, testing, or conducting research including, but not limited to, machine shops, carpentry shops, art studios, scene shops, makerspaces, testing facilities, and laboratories. Shops must meet the criteria specified in the shop safety policy: <https://ehs.umass.edu/shop-safety-program>