HARVARD
Campus Services
ENVIRONMENTAL HEALTH & SAFETY

Guidelines for Design

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1.0 PURPOSE OF THE MANUAL

Harvard University expects Architects, Engineers, and Designers to construct campus buildings that meet building codes and regulatory standards and also provide a safe and healthy environment for occupants and maintenance personnel. As part of the hiring process, the University establishes a formal contractual agreement with Architects, Engineers and Designers by executing a standard form of agreement for applicable services (i.e., consulting, design or construction services). As part of this agreement, the Architect and the Architect's consultants are required to provide design services in accordance with all current laws, statutes, ordinances, building codes, rules and regulations applicable to the design of a project. This manual provides some additional background on certain design requirements that relate to environmental, health and safety (EH&S) issues. This manual does not address and is not intended to abrogate 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.

This manual is divided into two basic sections. The first section, General Design Considerations, highlights general EH&S issues related to both safety as well as the installation of certain building components (e.g., HVAC systems, air emission sources, fuel storage tanks). The second section, Specific Facility Design Considerations, highlights certain EH&S issues related to a specific type of facility (e.g., food service establishment, laboratory).

In addition to the design issues that are addressed in this manual, there are certain EH&S issues that may need to be addressed more specifically for a particular project. Adequate management of these issues typically involves the need to retain the services of a specialized environmental consultant due to the stringent regulatory or permitting requirements. EH&S has prepared numerous tools and resources that can aid the Project Manager and Architect in understanding these issues more fully and incorporating them into the design process appropriately.

These resources cover specific EH&S issues, including:

- Soil Management

- Ground Water Management
- Storm Water Management
- Asbestos Abatement
- Lead Paint Abatement
- Miscellaneous Hazardous Materials Abatement
- Underground Storage Tank Removal
- Installation of Air Emission Sources
- Installation of Geothermal Wells

Please visit the EH&S website or call at 617-495-2060 to get additional information on these topics.

2.0 GENERAL DESIGN CONSIDERATIONS

2.1 SAFETY

2.1.1 AUTOMATED EXTERNAL DEFIBRILLATOR (AED)

In Massachusetts, Automated External Defibrillators, AEDs, are required in health clubs (MGL, Part I, Title XV, Chapter 93, Section 78A), nursing facilities (105 CMR 150.000), public schools (MGL Part I, Title XII, Chapter71, Section 54C), and dental offices (234 CMR 6.00). In accordance with Massachusetts laws, the following Harvard University facilities require to be fitted with an AED:

- Gymnasiums, health spas, ports, tennis, racquet ball, platform tennis and health clubs, figure salons, health studios, gymnasiums, weight control centers or studios, martial arts and self-defense training centers, or any other similar course of physical training.
- Dental offices where anesthesia is administered (General Anesthesia and Deep Sedation, Minimal/Moderate Sedation including Nitrous Oxide-oxygen in Conjunction with any Anesthetic or Enteral Sedative Agents).

While AEDs are only mandated in certain facilities, Harvard University supports fitting AEDs, to increase survival rate for cardiac emergencies, in targeted public areas through the Harvard Public Access AED Program where many people transit or gather such as amphitheaters, office buildings, large, shared spaces, research facilities, large classroom facilities, student halls, childcare centers, among others.

By fitting an AED/s into a facility, the school or unit agrees to abide by the Harvard AED Program, which is administered by EH&S. University Health Services (UHS) provides the required medical oversight to the AED program. The Harvard AED Program standardizes the type of AED used across the University (ZOLL AED Plus – see AED Types), defines roles and responsibilities, outlines routine inspections, and maintenance of the AEDs. Schools and/or units are responsible for any cost associated with inspections and maintenance of AEDs.

AED installation must comply with the following:

- ADA guidelines
- Fire Codes
- Electrical Codes

AED Types

Item (Model/Part Number)	Part Number
ZOLL AED-Plus Unit	20100000101011010
Lithium-Ion Batteries - 5 Year Life	8000-0807-01
Adult CPR-D Pads - 5 Year Shelf Life	8900-0800-01
Pediatric pads (Required in Child Care Centers) 2 Year Shelf Life	8900-0810-01
3-D Wall Sign	9310-0738
7-inch Wall Mounting Cabinet	8000-0817
Semi-Recessed Wall Cabinet	8000-0814
Fully Recessed Wall Cabinet	8000-0811

2.1.2 CONFINED SPACES

All structures shall be designed to minimize the number of confined spaces. A confined space is an area that meets the following three requirements:

- It is large enough for an employee to enter and perform assigned work,
- It has limited or restricted means for entry or exit, and
- It is not designed for continuous employee occupancy.

A confined space can also have hazards that make them significantly more dangerous to enter. These spaces are considered permit required" confined spaces, which means one or more of the following characteristics exist:

- Contains or has a potential to contain a hazardous atmosphere;
- Contains a material that has the potential for engulfing an entrant;
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or
- Contains any other recognized serious safety or health hazard.

When the creation of a permit required confined space is unavoidable, one or more of the following actions shall be taken to reduce the hazards associated with the space:

- Install a remote monitoring and inspection system and automated cleaning system to eliminate or minimize the need for entry into a confined space;
- Provide mechanical ventilation (mechanical ventilation in confined spaces avoids build-up of contaminants or combustible atmospheres);
- Design adequate means of entry and exit (provisions should be made for the entry and exit for persons who may be required to wear personal protective equipment, a breathing apparatus, and protective clothing);
- Design suitable illumination on emergency power, not timer switches (lighting shall be sufficient for safe

entry, conducting work, and exiting); and,

- Eliminate fall hazards (provide fixed ladders, guardrails, platforms, and anchor points for personal fall arrest systems) and provide non-slip work surfaces (e.g., textured flooring).

2.1.3 FALL HAZARDS

Structures shall be designed to eliminate fall hazards during routine and non-routine use, maintenance, repairs, and all other purposes. Where exposure to fall hazards are unavoidable, the hazards involved in working at heights above six feet should be minimized by incorporating the following into building design:

- Install permanent fall arrest anchor points for the use of personal fall protection equipment. Anchorages to which personal fall arrest equipment is attached shall be capable of supporting at least 5,000 pounds (22.2 kN) per employee attached as required by the Occupational Health and Safety Administration (OSHA).
- Install guardrails and toe boards where people are exposed to falls of six feet or greater. Standard railings with standard toe boards shall be installed on all exposed sides except at the entrance to the opening. The railings and toe boards shall be constructed in accordance with the American National Standards Institute (ANSI) standard A1264.1-2017.
- In addition, OSHA requires that fall protection be provided when working over dangerous equipment and machinery, regardless of the fall distance.
- Any roof top equipment or drains within 15 feet of the leading edge of the roof top must be protected with a passive or active fall protection system. In some applications, a combination of both systems may apply. Corralling equipment with railing leading back to a safe walking path may also be an alternative.
- Ladder and hatch access must also be protected from the leading edge of the roof (within 15 feet) and must utilize railing (passive fall protection system) or anchor points and/ or life lines (active fall protection system) to safe guard workers on the roof top or elevated work space.

2.1.4 FIXED LADDERS

Where it is necessary to install a fixed ladder, it shall comply with the OSHA standard 29 CFR 1910.27. It shall also be constructed in accordance with ANSI standard A14.3-2008 These standards prescribe minimum requirements for design, construction, and use of fixed ladders. It also sets forth requirements for cages, wells, and ladder safety systems used with fixed ladders to minimize personal injuries.

2.1.5 SKYLIGHTS

Skylights shall be designed to prevent people from falling through them. OSHA concludes that, "a skylight shall be regarded as a hatchway, i.e., an opening in the roof of a building through which persons may fall." (29 CFR 1910.23(a)(4)). Therefore, OSHA regulations require that skylights shall be guarded by a standard skylight screen or a fixed standard railing on all exposed sides.

Requirements for standard skylight screens are provided in the OSHA regulation 29 CFR 1910.23(e)(8). The regulation states that skylight screens shall be of such construction and mounting that they are capable of withstanding a load of at least 200 pounds applied perpendicularly at any one area on the screen. They shall also be of such construction and mounting that under ordinary loads or impacts, they will not deflect downward sufficiently to break the glass below them. The construction shall be of grillwork with openings not more than 4 inches long or of slat work with openings not more than 2 inches wide with the length unrestricted.

2.1.6 WINDOW WASHING

Roof anchors are to be installed on all new buildings that require windows to be washed by suspended scaffolds, boatswain's chair, rope descent system or other suspended system. The installation shall be in accordance with ANSI and International Window Cleaning Association (IWCA) standard I 14.1-2001. All powered platforms for window cleaning shall be constructed in accordance with the American Society of Mechanical Engineers (ASME) standard A 120.1-2001 and ASME 120.1b-1999.

2.2 HEATING VENTILATION AND AIR CONDITIONING SYSTEMS (HVAC)

2.2.1 VENTILATION

All occupied indoor spaces shall be provided with natural or mechanical ventilation or a combination of both. The Architect must fully design and document the design criteria for the proposed HVAC system as part of an

HVAC Systems specification that is included as part of their overall design documents. Natural ventilation shall meet the requirements of the Massachusetts Building Code (9th Edition); 780 CMR 1203.4 and Section 402 of International Mechanical Code (2009). Mechanical ventilation shall meet the requirements of Section 403 of the International Mechanical Code (2009). Re-circulating Variable Air Volume (VAV) system controls shall meet minimum ventilation rates specified in Section 403.3 of the International Mechanical Code (2009) at all supply airflow rates.

2.2.2 RECIRCULATION OF SUPPLY AND EXHAUST AIR

Recirculation of return, transfer or exhaust air must meet the requirements of Section 403.2.1 of the Massachusetts Mechanical Code. In addition, exhaust air from Laboratory Hoods or other exhaust meeting the definition of Class 4 in Section 5.16.1 ASHRAE Standard 62.1 (2016) as determined by Harvard EH&S shall not be recirculated. Enthalpy wheels shall not be used in any Class 4 exhaust.

2.2.3 TEMPERATURE CONTROL AND THERMAL COMFORT

Spaces intended for human occupancy shall be provided with active or passive heating system that maintains a minimum temperature of 68°F (20°C) as specified in Section 1204 of the Massachusetts Building Code and Section 309 of the International Fire Code (2009) The installation of portable space heaters shall not be used meet this requirement.

Systems should be designed to meet Harvard University Temperature Policy of 68°F-71°F Winter and 74°F-76°F Summer unless specific applications require temperatures out of this range.

Performance criteria shall be documented in the design phase and verified during the commissioning of the HVAC system.

2.2.4 NOISE AND ACOUSTICAL INSULATION

HVAC systems noise levels shall meet Room Criteria (RC) noise levels specified as per ASHRAE Handbook (2015) Applications, Chapter 48 Noised and Vibration Control. Reduce fan and air noise by the use of sound attenuators and vibration isolators where appropriate. Use round or oval ducts, where feasible, instead of rectangular, as well as larger ducts and fans at lower RPM.

2.2.5 DUCT INSULATION

Duct Insulation shall meet the requirements section 604 of the Massachusetts Mechanical Code (IMC-2009).

2.2.6 AIR INTAKES

The location of outdoor air intakes shall meet the requirements of Section 2801.2.2.1 of Massachusetts Building Code.

Design should meet the requirements of ASHRAE 62.1-2016, Section 5.5, Outdoor Air Intakes.

2.2.7 FILTRATION

Filters shall meet the requirements of Massachusetts Mechanical Code (IMC2009) section 605 Air Filters.

All outdoor air must be filtered upstream of cooling coils or other wetted surfaces. Use filters with a Minimum Efficiency Reporting Value (MERV) of 8 or greater per Section ANSI/ASHRAE 62.1- 2016 Ventilation for Acceptable Indoor Air. See ASHRAE Handbook (2016) Chapter 29 Air Cleaners for Particular Contaminants for MERV values for typical applications. Potential outdoor air-pollution sources and particulate levels required for intended use of the indoor space should be considered when specifying filters.

2.2.8 FANS

All moving parts such as belts and drives shall be appropriately guarded as per OSHA 1910, Subpart O, Machines and Machine Guarding. Fans shall be designed and positioned to provide unencumbered access for inspection and maintenance.

2.2.9 DRAIN PANS

Drain pans shall be provided beneath all dehumidifying cooling coil assemblies and all condensate producing heat exchangers. Drain pans should meet design requirements of Section 5.10 Drain Pans in ANSI/ASHRAE 62.1-2016.

2.2.10 EXHAUST VENTILATION

Minimum general mechanical exhaust ventilation shall be provided as recommended for select occupancies in Table 403.3 Minimum Ventilation Rates in the Massachusetts Mechanical Code (IMC2009). See Section 3.3

Laboratory Local Exhaust Ventilation for fume hood, gas cabinets and other specialized local exhaust ventilation.

Location of exhaust outlets and vents shall meet requirements of Section 501.2.1 Location of exhaust outlets of the Massachusetts Mechanical Code (IMC2009).

Aesthetic enclosures of exhaust outlets should be of open louvered type allowing horizontal winds to ventilate enclosure. Exhaust outlets shall exhaust outside aesthetic enclosures and shall not be located in the same enclosure as any air intakes.

2.2.11 FIN-TUBE COILS & HEAT EXCHANGERS

Fin-tube coils and heat exchangers providing dehumidification should meet the requirements of Section 5.11 of ANSI/ASHRAE 62.1-2016.

2.2.12 HUMIDIFIERS & WATER SPRAY SYSTEMS

Humidifiers and water spray systems should meet the requirements of Section 5.12 of ANSI/ASHRAE 62.1-2016.

2.3 AIR EMISSION SOURCES

2.3.1 PERMITTING

Air permits are typically required before installation of equipment that is a source of air pollution. In general, any equipment that burns fuel or emits air pollutants to the outdoor air may need a permit and have to be installed and operated in accordance with Environmental Protection Agency (EPA) and Massachusetts Department of Environmental Protection (MassDEP) Requirements. This equipment includes:

- Boilers, Engines, Turbines;
- Emergency Generators;
- Refrigerant Containing Devices (≥ 5 pound reservoir)
- Cooling Towers;
- Process Equipment Sources of Volatile Organic Compound (VOC) (e.g., solvents, paints, degreasers, etc.)

that have the potential to emit greater than one ton of VOCs.

For this equipment, EH&S provides the following services:

- Managing communication with regulatory agencies on issues including obtaining or modifying existing permits,
- Providing technical information, resources and training during design, construction and operation.
- Vendors should be prepared to supply technical information that aids in permitting and recordkeeping efforts.

All air emission sources that are installed at the University, including generators, boilers and cooling towers, must meet the minimum design criteria discussed in paragraphs 2.3.2: Emergency Generators through 2.3.4: Cooling Towers. In addition, certain air emission sources that exceed a specified regulatory threshold require permitting and/or plan review from the MassDEP prior to installation. These thresholds are defined in the following sections and if your project involves one or more of these permitted sources, then a qualified air emission consultant must be retained. Please forward information regarding permitting of these engines to EH&S to include in our University Permit.

2.3.2 EMERGENCY GENERATORS

DEP has stringent requirements and expectations for generator installations at institutional settings in Massachusetts that designers may not have experience with so the applicable regulations related to emissions, stack height, and emission dispersion is included in this document and are directly sourced from the DEP Emergency Engine Environmental Certification Workbook and applicable regulations.

Emission Limits: Compression- or spark-ignition engine must comply with the applicable EPA Non-Road Compression Ignition engine emission standards for the engine model year that coincides with the calendar year of installation.

- For emergency engines burning fuel oil a statement that a certificate of conformity has been obtained pursuant to EPA's non-road compression ignition engine requirements.
- For emergency engines burning natural gas or propane, documentation from the supplier stating that the

engine, including any add-on catalytic emission control, meets the non-road compression ignition emission limitations for the engine power rating and model year.

Engine may only be fueled with ultra-low sulfur diesel (15 parts per million (ppm) sulfur).

An emergency engine shall be equipped with a non-turn back hour counter to track hours of operation

Another potential result of improper attention to locating your unit is the creation of a noise nuisance. Units should be housed in enclosures specifically designed to attenuate sound. Similar to exhaust impacts, locations that will impact people, such as locations near windows and doors that open, and other sensitive receptors, must be avoided.

For generators with internal fuel storage tanks, location siting should also take into consideration distance from roadways and/or access areas for fuel delivery vehicles as fuel delivery vehicles typically need to park within 100 feet of the tank fill port.

Engine Exhaust Stack Requirements

The engineer must design the engine so that exhausts use a stack that discharges so as to not cause a condition of air pollution and employ EPA Good Engineering Practice (GEP) to ensure the exhaust does not negatively impact the air quality of nearby sensitive environmental receptors above the Federal National Ambient Air Quality Standards (NAAQS). Such practices include the following:

- The stack must discharge vertically upward. Stack heads, or devices used to prevent precipitation from entering the stack, must not restrict the vertical flow of the exhaust gas stream. Devices such as “shanty caps” and “egg beaters” are prohibited. Coning of the top of the stack is acceptable. No more than a one-inch change in diameter to every five inches in length of cone is recommended in order to avoid serious backpressure that may affect air flow at the point of origin.
- All engines or turbines shall utilize an exhaust stack that discharges so as to not cause a condition of air pollution.
- Exhaust stacks shall be configured to discharge the combustion gases vertically and shall not be equipped with any part or device that impedes the vertical exhaust flow of the emitted combustion gases.
- Any emission impacts of exhaust stacks upon sensitive receptors including, but not limited to, people,

windows and doors that open, and building fresh air intakes shall be minimized by employing good air pollution control engineering practices. Such practices include without limitation: avoiding locations that may be subject to downwash of the exhaust; and installing a stack of sufficient height in locations that will prevent and minimize flue gas impacts upon sensitive receptors.

- An emergency engine or emergency turbine with a rated power output equal to or greater than 300 kilowatts (kW) shall have an exhaust stack with a minimum stack height of ten feet above the rooftop or the engine or turbine enclosure, whichever is lower.
- An engine with a rated power output equal to or greater than one MW shall be equipped with an exhaust stack with a minimum stack height of 1.5 times the height of the building on which the stack is located. If the stack is lower than 1.5 times the building height or lower than the height of a structure that is within 5 L of the stack (5 L being five times the lesser of the height or maximum projected width of the structure), the owner/operator shall submit documentation that the operation of the engine or turbine will not cause an exceedance of any NAAQS.

Specific GEP requirements that must be satisfied include:

- The engine needs to be located in an area where the stack will not impact the air quality for "nearby" sensitive environmental receptors. The EPA GEP defines "Nearby" as a building or solid structure is within either 5 times the height or length of that structure from the stack or .5 mile whichever is less. (e.g., A building that is 10 feet tall 20 feet wide and is 40 feet from an engine stack would be considered "nearby" as it is less than 5x10 feet from the base of the proposed stack location.)
- The stack needs to be designed to meet EPA GEP height for each pollutant. This is generally defined as 1.5 times either the height or the width of nearby structures whichever is less. Note that MassDEP also recommends a minimum stack height of ten feet above the facility rooftop or the emergency engine or turbine enclosure, whichever is lower for all engines with a rated power output equal to or greater than 300 kW. This DEP requirement does not supersede the EPA GEP guidance (i.e., A 10-foot stack next to an open window does not satisfy EPA/DEP regulatory compliance requirements unless proven by a modeling assessment of the air quality impacts to that window).

The EPA offers additional GEP guidance.

All new emergency engines (even in kind replacements of existing units) require the project to demonstrate that the installation will satisfy all EPA/DEP requirements through air dispersion modeling. Contact EH&S for assistance in ensuring that the engine design will meet current regulatory requirements.

2.3.3 BOILERS

- The unit shall comply with the latest design guidelines of American Boiler Manufacturer's Association, and ASHRAE.
- Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
- All fuel gas piping systems, fuel gas utilization equipment and related accessories servicing the boiler shall be installed in accordance with National Fire Protection Agency (NFPA) 54.
- All full oil piping systems, fuel oil utilization equipment, and related accessories servicing the boiler shall be installed in accordance with NFPA 31 and permit requirements.
- All boilers having a heat input capacity greater than or equal to 3 MMBtu/hr but less than 10 MMBtu/hr need to be included in the University air permits and will be subject to maintenance and recordkeeping requirements.
- Before purchase and installation of boilers having a heat input capacity greater than 10 MMBtu/hr, a DEP approval is required in accordance with 310 CMR 7.02(1). Note that projects that involve the installation of a group of boilers within close proximity or using a single stack are typically considered one unit and will require DEP approval if the aggregate heat input capacity is greater than 10 MMBtu/hr, even if the individual units do not exceed the permitting threshold.

2.3.4 COOLING TOWERS

- Cooling towers thermal performance shall be certified in accordance with Cooling Technology Institute's STD-201.
- The fill material and water distribution systems servicing the cooling tower shall be made of materials

resistant to corrosion and heat.

- The unit shall be provided with drift eliminator that is made of material that is resistant to corrosion, decay and biological attack.
- The unit shall be equipped with a blowdown discharge flow meter.
- The installation of a cooling tower that has the potential to emit greater than one ton of particulate matter, a recirculation rate greater than 20,000 gpm, or total dissolved solids concentration in the blowdown greater than 1800 mg/l of blowdown requires an air permit.

2.4 INSTALLATION OF STORAGE TANKS

2.4.1 PERMITTING

The Contractor must be properly licensed and should be directed to perform the work and obtain the appropriate permits in accordance with all applicable Federal, state, and local regulations governing work involving the permitting of aboveground and underground storage tanks.

Aboveground storage tanks and associated piping shall be properly installed and permitted in accordance with, but not limited to, 40 CFR 112, 310 CMR 7.00 and 502 CMR 9.00.

Underground storage tanks and associated piping shall be properly installed and permitted in accordance with, but not limited to, 40 CFR 112, 310 CMR 7.00 and 310 CMR 80.00, with the manufacturer's instructions, and with "Petroleum Equipment Institute Publication RP100-97, Recommended Practices for Installation of Underground Liquid Storage Systems".

While the specific notifications, registrations, licensing and permitting may vary from various towns and jurisdictions, the typical approval process and document needed by the installation Contractor are as follows:

- Ensure that a permit has been obtained from the Massachusetts Department of Public Safety and the local Fire Department for heating oil tanks associated with fuel burning equipment, 527 CMR 4.03 (1)(b), 527 CMR 4.03 (1)(d).
- For tanks greater than 10,000 gallons containing a material other than water (including pressurized gases i.e., nitrogen), ensure that an application for registration and license has been submitted to the

Massachusetts Department of Public Safety, the Massachusetts Department of Fire Services 502 CMR 5.00, the local Fire Department, and the License Commission, 502 CMR 9.03 (B).

- For gasoline and diesel fuel, ensure that a tank registration/permit has been submitted to the Massachusetts Department of Fire Services and the local Fire Department.

The design of underground and aboveground storage tanks and all associated appurtenances that will be installed on University property must be completed by a Massachusetts licensed professional qualified by the state to design such items and must be reviewed by a Professional Engineer. In addition, review of design documents, including plans, schematics, notifications and permit applications, must be conducted by the University's' EH&S Department and Engineering and Utilities Department who will review the submittals to ensure compliance with University permits and policies.

In addition to complying with all Federal, state, and local regulations governing the permitting of fuel storage tanks, the minimum design criteria outlined in Section 2.4.2 Aboveground Storage Tanks (ASTs) and Section 2.4.3: Underground Storage Tanks must be met.

2.4.2 ABOVEGROUND STORAGE TANKS

Tanks installed in underground vaults, which are not buried and otherwise accessible for inspection, are considered aboveground storage tanks (AST) and are subject to all applicable AST requirement.

Where possible, on-tank suction-type pumps should be employed to prevent and minimize leaks. This arrangement eliminates leaking valves and fittings.

Tanks should not be located directly under building eaves where they may be subject to falling snow or increased external damage from dripping water.

To prevent and minimize oil spill and overfill, the tank shall have at minimum one or combination of the following:

- Audible high level alarm activated by a float switch at a specified fill level,
- Valve located within fill-pipe access to close automatically at a specified fill level,
- Direct reading level gauge at the tank, which is visible from fill pipe location, and

- Secondary containment, capable of containing 110% capacity of the tank or largest tank in the containment area.

The tank systems shall have properly sized vent for emergency pressure relief.

The tank should be protected from vandalism, collision and accidental damage if the unit has to be placed outside a building. This is generally accomplished with bollards or wire fences around the tank.

Tanks that are made of less corrosive material such as polyethylene should be considered.

Tanks located in areas subject to flooding (i.e., basements) shall be secured to prevent them from floating.

Location of fill port for tank shall take into consideration distance from closest roadway and/or access point for fuel delivery vehicle. Most delivery vehicles need to be within 100 feet of the fill port. Preferably the driver will be able to see the fill port and the delivery vehicle while filling.

Refer to Harvard's SPCC Plan for additional information.

2.4.3 UNDERGROUND STORAGE TANKS

A tank installed in an underground vault that is not buried may be subject to AST requirements.

Underground Storage Tanks (USTs) and associated piping shall be properly designed and protected from corrosion. These include, but are not limited to the following:

- The tank is constructed of fiberglass-reinforced plastic in compliance with "Underwriters Laboratories Standard 1316-83-87; Standard for Glass-Fiber-Reinforced Plastic "Underground Storage Tanks for Petroleum Products" or "American Society of Testing and Materials Standard D4021-86; Standard Specification for Glass-Fiber-Reinforced Polyester Underground Petroleum Storage Tanks."

  To minimize risk of UST piping corrosion, the piping system is installed in accordance with American Petroleum Institute-API Recommended Practice 1632.

The tank is provided with overfill, and leak detection system capable of minimizing the risk of oil spills. These include, but are not limited to, the following:

- A device which shall automatically shut flow into the tank when the tank is no more than 90% full.

- A device which shall alert the individual delivering product when the tank is no more than 85% full by restricting the flow into the tank or triggering a high-level alarm.
- Continuous In-Tank Leak Detection System installed in accordance with the manufacturer's instructions and capable of detecting a leak or discharge of 0.20 gallons per hour with the probability of detection of 0.95 and a probability of false alarm of 0.05 as determined by an independent testing laboratory using the EPA Standard Test Procedures for Evaluating Leak Detection Methods (EPA/530/UST-90/004 through 010) or other equivalent test procedures.
- Leak detection alarms shall be electronically transmitted to the appropriate Operations Center.

Location of fill port for tank shall take into consideration distance from closest roadway and/or access point for fuel delivery vehicle. Most delivery vehicles need to be within 100 feet of the fill port. Preferably the driver will be able to see the fill port and the delivery vehicle while filling.

2.5 FLAMMABLE OR COMBUSTIBLE LIQUID STORAGE

2.5.1 CONTROL AREAS

Control areas are spaces within a building, which are enclosed and bounded by exterior walls, fire walls, fire separation assemblies and roofs, or a combination thereof, where quantities of hazardous materials not exceeding exempt amounts are stored, dispensed, used or handled.

Where exempt amounts are not exceeded control areas shall be used to store flammable and combustible liquids inside buildings. The design, construction, location and number of control areas shall meet the requirements of the Massachusetts State Building Code (MSBC) 780 CMR 417.2 and shall not exceed allowable amounts of hazardous materials per control area as specified in 780 CMR Tables 307.8(1) and 307.8(2). Maximum quantities may be increased when storage is in a building equipped throughout with automatic sprinklers in accordance with 780 CMR 906.2.1.

Maximum quantities may also be increased if flammable materials are stored in approved cabinets, gas cabinets, fume hoods or ventilated cabinets.

Reference 537 CMR 1:00 Massachusetts Comprehensive Fire Code based on 2015 edition of NFPA 1.

The number of permitted control areas per floor, the percent of allowable exempt quantities per control area, and the degree of vertical fire separation shall meet the requirements of 780 CMR *Table 417.2 Permitted Control* Areas. Floor and supporting structures for all floors within a control area shall have a minimum of 2-hour fire separation. Fire separation assemblies shall be in accordance with 780 CMR 709.

Control areas are not permitted more than two levels below grade.

2.5.2 INSIDE LIQUID STORAGE ROOMS

Location

If amounts of stored flammable and combustible liquids exceed allowed amounts per control area an inside liquid storage or cut off rooms (a room including one or two outside walls) is required. Inside storage rooms shall not be constructed in basements. Inside liquid storage areas shall be considered H-2 occupancy.

Design

Inside storage rooms shall be constructed to meet the applicable requirements of 780 CMR 417.5 and the Massachusetts Board of Fire Prevention Codes 527 CMR 14.03 (18)d and NFPA 30 2003 Flammable and Combustible Liquids Code, section 6.4.

Inside storage area shall not exceed 500 square feet. Cut off rooms exceeding 500 square feet shall have at least one exterior door approved for Fire Department access.

Fire Resistance Ratings

Fire resistance ratings for inside storage areas shall meet the minimum requirements of section 6.4.2.2 of NFPA 30. In mixed use groups fire separation shall meet the 4-hour separation specified in 780 CMR 313 for H-2 user group.

Fire doors shall be installed in accordance with NFPA 80, Standard for Fire Doors and Fire Windows.

Fire Detection

All inside flammable storage areas shall be provided with fire detections system as per 780 CMR 417.5.3.

Sprinkler Protection

Inside flammable liquid storage rooms shall be protected by an automatic fire protection system installed in accordance with 780 CMR 906.2.1.

Electrical

Electrical wiring and equipment located in inside rooms used for Class I liquids shall be suitable for Class I, Division 2 classified locations. NFPA 70, National Electrical Code, provides information on the design and installation of electrical equipment.

Ventilation

Every inside room shall be equipped with continuous mechanical exhaust ventilation system. Mechanical ventilation systems shall provide at least one cubic foot per minute of exhaust per square foot of floor area, but not less than 150 CFM. The mechanical ventilation system shall be equipped with an airflow switch or other reliable method which is interlocked to sound an audible alarm upon failure of the ventilation system. Exhaust ventilation shall be taken from the ceiling and the floor, depending on the density of the vapor produced. The location of both the exhaust and inlet air openings shall be arranged to provide, as far as possible, air movement across all portions of the floor to prevent the accumulation of flammable vapors.

Exhaust from the room shall be vented directly to the exterior of the building without recirculation. All ducts shall comply with NFPA 91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids.

Storage

In every flammable storage room, an aisle of at least 3 feet wide shall be maintained. Containers over 30 gallons capable of storing Class I or Class II liquids shall not be stored more than one container high.

Spill Control

Flammable liquid storage rooms shall be provided with spill control and drainage control.

Portable Extinguishers

At least one portable fire extinguisher, having a rating not less than 20- B, shall be located outside of but not more than 10 feet from the door opening into the liquid storage room.

2.5.3 APPROVED FLAMMABLE STORAGE CABINETS

Storage cabinets shall be designed and constructed to meet specifications detailed in 527 CMR 1.00 Massachusetts Comprehensive Fire Safety Code – based on the 2015 edition of NFPA 1, Chapter 66 Flammables and Combustible Liquids, Section 66.9.9 Flammable Liquids Storage Cabinets New cabinets shall meet the 2021 edition of NFPA 30, Chapter 9, Section 9.5 Liquid Storage Cabinets.

Any listed storage cabinet that has been designed and constructed to limit the internal temperature during fire testing as specified in NFPA 251, Standard Methods of Tests of Fire Resistance of Building and Construction and Materials.

Any metal storage cabinets constructed in the following manner:

- The bottom, top, door, and sides of the cabinet are double-walled with 38 mm (1½ inches) air space and constructed with No. 18 gauge sheet steel or thicker.
- Joints are riveted, welded, or made tight by some equally effective means.
- The door is provided with a three-point latch arrangement, and the door sill is raised at least 50 mm (2 inches) above the bottom of the cabinet to retain spilled liquid within the cabinet.
- New cabinets shall have self-closing doors.

Any wooden cabinet constructed in the following manner:

- The bottom, sides, and top are constructed of exterior grade plywood that is at least 25 mm (1 inch) thick and of a type that will not break down or delaminate under fire conditions.
- All joints are rabbeted and fastened in two directions with wood screws.
- Where more than one door is used, there shall be a rabbeted overlap of not less than 25 mm (1 inch).
- Doors are equipped with a means of latching, and hinges are constructed and mounted in such a manner as to not lose their holding capacity when subjected to fire exposure.
- A raised sill or pan capable of containing a 50 mm (2 inches) depth of liquid is provided at the bottom of

the cabinet to retain spilled liquid within the cabinet.

- New cabinets shall have self-closing doors.

Venting of Flammable Storage Cabinets

The storage cabinet shall not be required to be vented for fire protection purposes, and vent openings shall be sealed with the bungs supplied with the cabinet or with bungs specified by the cabinet manufacturer.

However, if the storage cabinet is vented for any reason, the cabinet shall be vented directly to outdoors in such a manner that will not compromise the specified performance of the cabinet and in a manner that is acceptable to the authority having jurisdiction (including thermally-actuated intake and exhaust vent dampers, flame arrestors on the cabinet vent openings and exhaust through the vent opening closest to the cabinet bottom).

2.6 LASER SYSTEMS

2.6.1 PERMITTING/REGISTRATION

All applicable regulations and Harvard University policy must be adhered to during the design and construction of laser systems. Regulatory guidance can be found in Commonwealth of Massachusetts Regulations 105 CMR 121: Laser Systems. Harvard policy can be obtained from the Harvard University Radiation Safety manual and interpretation of regulations and practical guidance may be obtained by contacting the Harvard University EH&S Laser Safety Officer (LSO).

In addition, it is required that the Class 3B and/or Class 4 laser system(s) be registered with the Harvard University Radiation Protection Office. This registration process is facilitated through the Application for Non-ionizing Radiation Device Permit obtained from the LSO. Specific guidance on the safety requirements for both Class 3b and Class 4 lasers is outlined in Section 2.6.2: Class 3B Laser Facilities and Section 2.6.3: Class 4 Laser Facilities.

2.6.2 CLASS 3B LASER FACILITIES

- Class 3B laser systems must be controlled to permit operation only by personnel who have been trained in the operation of the laser, laser system and laser safety. Access to the area by spectators must be limited.

This laser controlled area must, therefore, have positive access control.

- The Class 3B laser controlled area must be posted with appropriate warning signs, posted at the entryway(s). The Harvard University LSO can provide appropriate postings which consist of self-adhesive labels. Audible or other visible warning devices may be required for Class 3B lasers, as identified by the LSO. They are required for Class 4 lasers (see Section 2.6.3: Class 4 Laser Facilities).These devices would be furnished by the contractor.
- Direct or scattered laser light cannot escape the laser controlled area in excess of the maximum permissible exposure (MPE). This can be accomplished by eliminating or filtering windows or other open or transparent structures. Covers or filters over such structures must be labeled to prevent unauthorized removal.
- Construction materials must not support the generation of specular reflections. Diffuse reflections are allowed, and may be provided for by avoiding smooth, polished surfaces, particularly on walls and other vertical, planar surfaces.
- The exposed beam path must be at an elevation above or below the eye level of a person in a seated or standing position.
- Laser systems often require high voltage and high amperage electrical services. Electrical services for lasers must meet all electrical safety codes, including lock out/tag out.
- Some laser systems use hazardous chemicals, and some generate hazardous air contaminants. Appropriate hazardous chemical ventilation systems must be provided. Appropriate safe liquid handling methods must be provided as well.

2.6.3 CLASS 4 LASER FACILITIES

All Class 3B laser facility safety design criteria must be provided for, in addition to the following:

- Class 4 laser controlled areas and entryways must be designed for rapid egress at all time, especially under emergency conditions.
- For emergency conditions there shall be a clearly marked emergency “panic button” capable of

deactivating the laser or reducing its output to a level at or below the MPE.

- One of three entryway controls is to be provided following consultation with LSO:
    - **Non-defeatable area or entryway safety controls:** These are non-defeatable safety latches or interlocks that deactivate the laser or reduce output to below the applicable MPE in the event of unexpected entry into the Class 4 laser controlled area.
    - **Defeatable area or entryway safety controls:** If non-defeatable area or entryway safety controls limit the intended use of the laser or laser system, defeatable safety latches or interlocks that deactivate the laser or reduce output to below the applicable MPE in the event of unexpected entry may be used.
    - **Procedural area or entryway safety controls:** Where non-defeatable or defeatable area or entryway safety controls limit the intended use of the laser or laser system, procedural controls such as a door, blocking barrier, screen or curtain shall be used to block, screen or attenuate the laser radiation at the entryway. Barriers must not support combustion or release toxic fumes following a laser exposure.
- At the entryway to the Class 4 laser controlled area there shall be a visible or audible signal indicating that the laser is energized and operating. Visible warning lights must be of a color that may be seen when personnel are wearing their laser safety glasses. The Contractor is responsible for obtaining the visible or audible warning sign. The warning sign should be such that it illuminates only when the Class 4 laser is on, and it should be flashing to make it stand out. These devices may also be required inside the laser controlled area at the direction of the LSO.
- Where necessary, for example in high noise areas, audible warning signs may be required. Considerations for the hearing and visually impaired shall also be made.
- Class 4 lasers may ignite combustible materials. As such, combustible materials must be restricted from exposure to the direct beam or specular reflections, and to only those materials absolutely necessary.

2.7 PEST CONTROL

There are several aspects of a construction project that should consider pest control issues as part of their design considerations, including design of building penetrations, landscaping, and drainage.

The following issues should be addressed as part of the design process in order to minimize or avoid pest problems after occupancy of a building:

- Entrance ways should be designed to prevent birds from perching directly overhead. Pigeons, starlings, finches and other bird droppings create aesthetic and health problems.
- Entry ways, including exit doors, electrical cables, exhausts, piping, plumbing and other penetrations through the building exterior should be rodent-tight.
- Air intake systems should be designed so that filters will block insects. If there is a bypass around the filters, flying insects will be brought into duct work and deposited in rooms nearby.
- Avoid planting a series of dense small bushes that attract litter and becomes cover for burrowing rodents. Keep the landscaping around the loading dock and dumpster open. Landscaping used to hide dumpsters from view may also serve as cover for rodent activity.
- Consider placing a perimeter of crushed stone around the outside of the building perimeter to keep pests from concentrating at building thresholds.
- Consider the impact of planting close to the building. Planting of trees close to a building will increase the probability of squirrels and raccoons crawling onto the roof and eventually trying to find a way inside.
- Install proper drainage to prevent standing water on grounds. This will reduce mosquito breeding habitats.
- If large sections of glass are installed be aware that this could cause the death of hundreds of birds unless the lighting reflects so birds do not try to fly straight through.
- Avoid design of overhanging ledges that provide the support for numerous paper wasp nests that end up stinging the occupants.
- Specify trash containers that are rodent and squirrel proof.

2.8 WORKSTATION DESIGN

Proper workplace and workstation design requires consideration of ergonomic impact on the worker. The following guidelines on proper workstation design are based on past workstation performance and should be considered:

Systems furniture works well because of its ability to be adjusted. Systems furniture allows you to create virtually endless varieties of configurations by mixing and matching the three main building blocks: panel, work surface, and storage areas.

Workstation height clearance for thighs and lower legs is 20-27 inches (51-69 cm), and 28.5 inches (72 cm) for a nonadjustable work surface at the front edge. An adjustable work surface should have an adjustable range between 19.5-28 inches (50-71 cm). Clearance for knee height is 19.6-25 inches (50- 63 cm) at 17 inches (43 cm) from the front edge of the work surface. Work surface thickness should be added to the clearance dimensions.

Public workstations should be easily adjusted and straightforward. Workstations should be designed to permit people a minimum separation of 48 inches (122 cm), with 96 inches (244 cm) being more desirable. Sitting wells (space under the desk) should be at least 32 inches (81 cm) wide under the work surface. If possible, the sitting well should also be 39 inches (100 cm) deep, to allow the user to stretch his or her legs when sitting.

Fixed millwork (custom millwork or other non-systems installations) should take into account the need for future adaptations, individual worker variability and changes in tasks. Ideally installations will allow for adaptability without significant change or modification.

Standard office desks are commonly 30 inches (76 cm) deep and come in a variety of widths. For writing tasks, an area of 12 inches (30 cm) wide and 16 inches (41 cm) deep, preferably 30 inches (76 cm) in both directions is recommended to allow for adequate writing space. The edges and corners of the work surface should be rounded (minimum radius of .01 inch or 3 mm) and have a non- reflective surface.

Keyboard trays that are too cumbersome, not fully adjustable or have knobs and other mechanisms underneath should not be used. Thigh and leg clearance as well as width clearance for thighs should be taken into account to ensure that the keyboard tray's mounting mechanisms and support arm do not obstruct. Keyboard trays should have 5 inches (12.5 cm) height-adjustability, 20˚ side to side articulation and +15˚ tilt. Some considerations include sufficient width to support the keyboard and mouse, or provision of a companion mouse tray. The keyboard tray should provide a stable surface and not bounce from normal keying motions.

Sit/stand work surfaces should adjust to 46 inches high. Work surface depth and width should be 30 inches. Knee depth should be 15 inches. They should provide a separate surface for keyboard/input device.

Flat panel LCD Monitors offer many advantages over CRT monitors. In general, they are lighter, take up much less desk space and are easier to adjust. They also use far less power and can represent a cost saving over time. Another approach is to buy a monitor that has an adjustable stand. In most cases these stands will not provide as much flexibility as a monitor arm. Some monitors appear to have height adjustability, some can be swiveled and turned and some can do both.

Chairs that are well-designed and appropriately adjusted are an essential element of a safe and productive computer workstation. Please see the following chair criteria table.

Chair Criteria

Guidelines	Area
Seat pan height-adjustable	16-21 inches (41-53 cm)
Seat pan depth-adjustable	15-17 inches (38-43 cm) with waterfall sloping front edge
Seat pan with adjustable	18-22 inches (46-56 cm)
Seat back tilt minimum range	0-15˚
Seat back height minimum	14 inches (36 cm), width min .12 inches (30cm)
Lumbar support location in lumbar region of the back	Lumbar support depth 1.2-2 inches (3-5cm)
Five-legged stability	Not Available

2.9 STORMWATER MANAGEMENT SYSTEMS

Regulations governing the operation, maintenance, and permits for installation of stormwater management devices vary by municipality and should be verified prior to proposing a device for installation.

- Cambridge Stormwater Management
- Boston Stormwater System

Any documentation sent to the respective municipality which will affect and/or dictate maintenance and operation of the device(s) once ownership is transitioned to Harvard shall be reviewed with EH&S prior to submittal.

Stormwater management systems include but are not limited to the following:

- Particle Separators,
- Bio-retention and Vegetated Swales,
- Porous Asphalt and Pavers,
- Leaching and Dry-well Systems, and
- Catch basins.

Devices injecting stormwater into the ground (i.e., leaching and dry-well systems) will need to be registered with the MassDEP under the underground injection control program, 310 CMR 27.00. Please check with EH&S prior to design to facilitate post project permitting and to understand if there is groundwater contamination in the area where stormwater should not be reinjected.

3.0 FOOD SERVICE ESTABLISHMENT AND RETAIL FOOD ESTABLISHMENT

3.1 PERMITTING

Cambridge

The process to apply for a permit to build, renovate or operate a food service establishment in Cambridge is specified in a document that you may obtain by contacting the city's Health Department. Note that the Project Manager should be provided with all permit applications and relevant design documents in advance of coordination with the City (with a copy to the Harvard University Sanitation Health Officer (SHO), 46 Blackstone Street, Cambridge, MA 02139) so that the appropriate internal review can take place.

For reference, the City of Cambridge outlines the follow steps for opening up a restaurant or food service establishment:

- The proposed location must comply with the Cambridge Zoning Ordinance. **Schedule an appointment with the Zoning Specialist** in order to obtain approval for this.
- Complete all necessary applications for obtaining a **Common Victualer's License** from the License Commission.
- If any type of building, renovation or repair work is to be done, the **necessary permits.**
- must be taken out, (i.e., building, plumbing, electrical, gasfitting, etc.).
- When required, a **Certificate of Occupancy** must be obtained in accordance with the MSBC, and the Cambridge Zoning Ordinance.
- When required, a **Certificate of Inspection** must be obtained in accordance with the MSBC.
- A **plan must be submitted for review to the Inspectional Services Department** to be kept for a permanent record in this department, as per Article X of the State Sanitary Code for Food Service Establishments. Please allow 30 days for this review.
- In conjunction with the previously-mentioned permits, a **Food Handler's Permit** must be granted by the Environmental Health Division prior to opening the food establishment.
- If applicable, a **Milk License and/or a Frozen Dessert License** must be obtained.

In Cambridge, all plans/permit applications are handled by the Inspectional Services Department, Environmental Health Division (contact: Kristin Fernandes, Inspection, 831 Massachusetts Avenue, Cambridge, MA 02139, 617-349-6100). The Environmental Health Division refers applicants to the following sources, sold in Massachusetts State House Book Store (except where indicated), for additional information:

- Cambridge Zoning Ordinance (sold in Cambridge City Clerk's Office)
- MSBC
- MA State Electrical Code
- MA State Plumbing/Gas Code

- MA Architectural Access Board
- State Sanitary Code for Food Service Establishments

Boston

The process to apply for a permit to operate a food service establishment varies somewhat from one jurisdiction to another. However, in all cases the Project Manager should be provided with all permit applications and relevant design documents in advance of coordination with the City (with a copy to the Harvard University Sanitation Health Officer (SHO), 46 Blackstone Street, Cambridge, MA 02139) so that the appropriate internal review can take place.

The process for the city of Boston requires that the applicant first applies for a Plan Review. This is done by submitting the city's Plan Review Application Form, along with three sets of plans for the proposed establishment, to the Health Department. These plans must be drawn to scale, with a legend, and be accompanied by a detailed, proposed menu. The plan review is scheduled in advance, by appointment, by calling the Health Department, and reviews take place on Thursday and Friday mornings between 9:00 and 11:00 a.m. The contact person for plan reviews is Mr. Tom Coffill, Director of the Health Division, who conducts the reviews. Mr. Coffill can be reached at (617) 961-3219, and an appointment is usually made for the review within a week of your call. Once the review is completed and approved, all three sets of plans are stamped, and the Health Department keeps one set. The applicant takes the other two stamped sets, keeping one, and bringing the remaining set of plans to the Building Department's Plans and Zoning office for their review, and hopefully, approval. The Building Department has their own Fire Safety Plans Examiner, who will look at fire. safety issues.

An important issue to consider for renovations is to determine what the establishment is zoned for, in terms of occupancy and use. For example, you may need to determine if the facility is zoned for eat-in only, take-out, outdoor seating, retail only, etc. This may affect what changes you want to consider if you are renovating.

When the Building Department has completed and approved the application, and construction is complete (with all necessary sign-offs by the Building Department), the applicant should bring a copy of the Certificate of Occupancy for the intended use, a Food Service Establishment Permit Application, all necessary fees, and a copy of the Food Protection Manager's current certificate to the Health Department. At this time a preoperation inspection will be scheduled. When the inspection has been satisfactorily completed, a Food Service Permit will be issued.

Note that the Massachusetts State Sanitary Code, Chapter 10, Minimum Sanitation Standards for Food Establishments, is referred to throughout as the Food Code (FC).

3.2 COORDINATION WITH HARVARD EH&S DEPARTMENT

In addition to submitting all permit applications to the Project Manager and the University SHO as previously noted, other relevant design documents must also be provided so that the SHO can perform an appropriate review of the proposed Food Service Establishment. These documents must be submitted at least one month prior to the construction bidding process so that the SHO's comments can be incorporated into the final design documents (the SHO will review information within 21 days of receipt). The documents include, but are not limited to:

- A complete hard copy of plans, a minimum of 11 inches by 14 inches in size, accurately drawn to a scale of ¼ inch to 1 foot.
- An equipment plan showing each piece of food equipment intended for use, in approximate scale, with its intended location on the plan.
- Indicate the location of all sinks on the plan, including hand washing, ware-washing, food preparation and mop sinks.
- Include an equipment schedule, numbering each piece of equipment and assigning a corresponding number on the plans.
- An equipment specification packet with cut sheets for all equipment.
- If the establishment will be serviced by a private well, submit a copy of the current water quality test results and documentation showing that the well has been approved by the required state and local regulatory authorities.
- A list of materials for all surfaces (floors, walls, countertops, cabinets, paints and finishes, etc.)
- Specifications for lighting levels in all areas (footcandles or lux).

- A list of all permits that have or will be applied for, including the date of submittal to the appropriate authority. Permits may include, but are not limited to, a food service permit, an electrical permit, a plumbing permit and a general building permit.
- The name of the contact person at the City Inspectional Services.
- An establishment menu, the seating plan specifying the number of seats, a schedule of operation, and an estimate of the number of meals served per meal period.

3.3 DESIGN CONSIDERATIONS

3.3.1 HAND SINKS

Installation shall be in accordance with requirements of Food Code (FC) 5-204.11, 5-203.11, and any other pertinent section of the Food Code, and shall be of a quantity and location to allow convenient use by employees in food preparation, food dispensing and ware washing areas. The placement of the hand wash sinks shall not contribute to a potential cause of cross contamination of clean surrounding areas, and sinks shall be fitted with stainless steel barriers on either side with rounded edges, of sufficient height to mitigate splash, with a low profile faucet.

3.3.2 VENTILATION HOODS

Ventilation hoods shall be installed whenever required by Building, Fire or Food Codes, and in accordance with FC 4-204.11, 6-501.14, 6-304.11, and any other pertinent section of the Food Code, or Building or Fire Codes, and whenever necessary to remove excessive heat, steam, vapors, smoke, obnoxious odors, or fumes. Such ventilation systems shall be designed and installed in order to prevent grease or condensation from collecting on walls and ceilings, or from dripping onto other surfaces or equipment. Ventilation systems shall not create a public health hazard, nuisance or unlawful discharge.

3.3.3 DRESSING AREAS & LOCKERS

Dressing areas shall be provided if employees routinely change their clothing in the establishment, and lockers or other suitable, secure storage shall be provided for employee belongings as stated in FC 6-305.11.

3.3.4 UNSHIELDED SEWAGE LINES

Food preparation activities, food or equipment storage and ware-washing activities shall not occur in areas beneath unshielded sewage lines. In addition, food storage may not be located in mechanical rooms or other areas prohibited by the FC 3-305.12, 4-401.11.

3.3.5 LIGHTING

Over food preparation areas, food or utensil or equipment storage areas, or ware washing areas must be coated or shielded to protect objects below in the event of breakage as stated in FC 6-202.11.

Minimum light intensity requirements must be met in all areas of Retail Food and Food Service Establishment defined in FC 6-303.11.

3.3.6 FOOD PREPARATION SINK

A designated food preparation sink shall be provided in all food service establishments where food is prepared. This sink shall be labeled “For food preparation only-No ware washing-No hand washing”. No soap dispenser or paper towel dispenser shall be located at this sink.

3.3.7 BACK FLOW PREVENTION DEVICES & AIR GAPS

Back flow prevention devices and air gaps shall be provided wherever is required by the Food Code. FC 5-202.13, 5-202.14, 5-203.14, 5-204.12 5-205.12, 4-101.14, and any other applicable section of the Food Code.

3.3.8 EQUIPMENT

Spacing and elevation of equipment must conform to the Food Code to facilitate cleaning and maintenance.

3.3.9 SNEEZE GUARDS

Sneeze guards or other effective methods must be used to protect food from contact with diners and other sources of environmental contamination, in areas where food is prepared, served, or displayed. FC 3-305.14, 3-306.11.

3.3.10 MECHANICAL WARE WASHING MACHINES

Household dishwashers are not approved for commercial application. Only dishwashers that properly wash, rinse and sanitize dishes may be considered. Commercial dishwashers must meet all local codes for commercial use. Typically for commercial dishwashing equipment, the first consideration should be whether to choose a high temperature machine, which sanitizes with the use of hot water for the wash and rinse cycles, versus a low temperature machine, which uses a chemical rinse to sanitize or kill pathogens on dishware and equipment. In either case, mechanical ware washing machines must display a manufacturer's data plate with operating specifications.

High Temperature Machines

These machines use water whose temperature is boosted within the machine to a customary minimum temperature of 150 degrees Fahrenheit for the wash cycle, and 180 degrees Fahrenheit for the rinse cycle. This high temperature water exits the manifold at the specified temperature and may safely drop to 160 degrees Fahrenheit at the dish or utensil. These temperatures effectively render pathogens harmless, and the hot water and detergent do an excellent job of emulsifying grease. The absence of a sanitizer on the dishware and equipment makes this the preferred choice for some, especially those who do not want a chemical residue on dishes.

Although a properly calibrated sanitizer in the final rinse of a low temperature machine is food safe, there are those (such as brewery personnel) who think that this sanitizer can leave a taste on glassware. High temperature machines must be tested at regular intervals to make certain that the machine is reaching the proper rinse and wash temperatures, and this is accomplished by the use of a temperature sensitive, disposable thermometer that is sent through a dish cycle, turning color if the proper temperature is reached. Alternatively, a maximum/minimum registering dishwasher thermometer can be sent through a cycle to register the highest temperature achieved. Proper calibration of the exterior machine temperature gauges also provides a fairly accurate look at the wash and rinse temperature at every dish load if these gauges are calibrated. Occasionally an establishment does not have water entering the machine at a high enough temperature to allow the booster to bring it up to the required levels. If this is the case, a dedicated hot water heater for the dishwasher can be provided. An exception to the 160-degree temperature requirement at the dish or plate is a stationary rack, single temperature machine that must reach 165 degrees Fahrenheit for the final rinse temperature. Always look at the machine's data plate to see the manufacturer's specification for proper operating temperatures.

Low Temperature Sanitizing Machines

Low temperature machines operate with a wash and rinse temperature of approximately 120 degrees Fahrenheit, depending on the manufacturer's specifications on the data plate. This temperature, in conjunction with the detergent in the wash cycle and the sanitizer in the final rinse, is adequate to effectively render pathogens harmless. However, common experience suggests that dishes must be more effectively rinsed prior to dishwashing, in order to remove greasy food residues at the lower temperatures. If the recommended temperatures are not reached, it is also possible food residues to remain on the plate or utensil. The strength of the sanitizing solution must be carefully monitored, and a chlorine-based sanitizer is the usual type for these machines. A test strip must be dipped into the rinse residue on a dish after passing it through the machine, and this sanitizer must register the proper concentration.

Newly installed low temperature machines are now required to have an audible or visible low-sanitizer level alarm. This requirement is interpreted differently by different jurisdictions and can be a sight- glass mounted in-line at the chlorine addition point, or an audible alarm set up at the dispenser, or a light alarm set up somewhere on or above the machine. These alarms must be monitored regularly by staff, as un-sanitized dishware can spread pathogens from one customer to another.

3.3.11 MINIMUM LIGHTING REQUIREMENTS

The Massachusetts State Sanitary Code For Food Service Establishments, 105 CMR 590.000 puts new emphasis on the levels of light intensity that must be present in locations where various tasks are performed, and equipment is located within the establishment.

Light intensity is measured at a point 30 inches above the floor and is measured in Lux or footcandles. A standard light meter can be used to determine if the proposed space meets the following guidelines:

Location Minimum Lighting Requirements

Minimum Required Footcandles (Lux)	Location
50 (540)	Surfaces where food employees are working with food.
50 (540)	Surfaces where a food employee is working with utensils or with equipment where employee safety is a factor (such as knives, grinders, slicers, saws, etc.).
20 (220)	Surfaces where food is provided for customer self-service, such as salad bars and buffets, or where fresh produce or packaged food is offered or sold.
20 (220)	Inside equipment, such as reach-in refrigerators and under- counter refrigerators.
20 (220)	In areas used for hand washing, ware washing, equipment and utensil storage areas, and toilet rooms.
10 (110)	In walk-in refrigerators or walk-in freezers, in dry food storage areas, and in other areas and rooms when they are being cleaned.

3.3.12 FOOD STORAGE ROOMS

Food storage rooms shall be designed to prevent rodent and insect entry. If drop ceilings are installed, the ceiling space above the tile field shall be sealed from rodent entry. All holes and penetrations shall be sealed with fire stop material. Doors shall be rodent tight when closed with a hard door sweep installed (rubber and brush sweeps are easily chewed through). Storage racks shall be used to keep food products off the floor.

3.3.13 LARGE AND SMALL TRASH RECEPTACLES

Large trash receptacles for handling food waste shall be of a self-contained compactor design. This will prevent rodents from feeding inside of the container by squeezing past a fixed piston unit. Small trash receptacles shall be constructed with hard lids and not made of rubber. The preferred design should have a sliding door that when closed will keep the container rodent tight.

3.3.14 LOADING DOCK DOORS

Loading-dock doors should fit tight against the ground. The bumpers shall be constructed with a hard material (rubber bumpers are eaten through by rodents).

3.3.15 FLOOR DRAINS

Floor drains shall be located in areas so that the lids can be removed for cleaning. If condensate is directed into a floor drain, the piping from the condensate should not prevent removal of the drain cover.

4.0 LABORATORY DESIGN

These guidelines provide general or specific lab design recommendations on topics that may directly affect the health and safety of laboratory operations. The guidelines are meant to supplement other sources of design information when developing project specifications. They are not meant to be used in lieu of appropriate regulatory and code reviews.

4.1 GENERAL LABORATORY VENTILATION DESIGN

4.1.1 PURPOSE

Provide a process for lab designers to make basic decisions about laboratory HVAC systems, for laboratories that include Biosafety Level (BL) 1 and BL2. Any special design requirements associated with non-standard laboratories such as high containment (BL3/4), clean rooms or labs requiring high hazard classification under Massachusetts Building Code (780 Code of Massachusetts Regulations) are not covered in this guideline.

4.1.2 DESIGN PROCESS

EH&S recommends that designers use the following process when determining the general design features of laboratory HVAC system. The process establishes 6-8 air-changes per hour (ACH) as an acceptable air exchange rate for most laboratories when in the occupied mode. No single ACH rate is appropriate for all laboratories, contaminants, or operations. In rare cases, lab-specific conditions may require increased ventilation. Air exchange rates less than 6 ACH are not recommended during occupied periods.

Review programming documents and/or lab operations to determine sources of emissions and equipment needs.

Determine the local exhaust ventilation required to control anticipated chemical and/or heat emissions. It is important to evaluate all opportunities to use local exhaust ventilation as noted as follows, since these are the most effective methods to reduce exposure risks and cooling requirements:

- Number and size of chemical fume hoods
- Gas Cabinets
- Vented equipment enclosures (consider 2-speed where appropriate for open/closed conditions
- Canopy hoods for local heat and or wet exhaust enclosures such as autoclaves
- Exhausted work benches
- Special Local Exhaust (e.g., exhaust lines for equipment exhaust discharge, snorkels)

Determine if local exhaust needs exceed cooling load/demand required for equipment (use plug loads, if possible), people and solar loads. If cooling loads are the driving factor for air exchange rates, consider alternative strategies to meet cooling load such as increased use of terminal cooling units, water-cooled laboratory equipment and/or dedicated exhaust for point heat sources (ovens, autoclaves, etc.).

For exhaust-driven labs, calculate air exchange rate of given design, using the expected net volume of the room (i.e., room volume minus the space occupied by fixed structures such as lab benches, ventilation equipment, etc.).

- If calculated air-exchange rate is greater than 8 ACH and lab-specific conditions do not require increased ventilation, consider VAV or high performance fume hoods to reduce exhaust volumes without eliminating exhaust devices. Refer to Section 4.2.1: Chemical Fume Hoods Design for fume hood design specifications, including the minimum flow for VAV hoods.
- If calculated occupied air-exchange rate is less than 6 ACH or lab-specific conditions require additional exhaust, increase general exhaust.
- Design HVAC equipment to meet at least 20% increase in exhaust or supply air demand above design conditions of laboratories (not necessary for support spaces). Diversity may be considered in large projects, where appropriate. Follow the specifications for supply air, exhaust air and ventilation load diversity in ANSI/AIHA Z9.5 Laboratory Ventilation.

4.1.3 UNOCCUPIED MODES

Laboratory room air-exchange rates may be reduced to 4 ACH during unoccupied mode. A laboratory is defined as unoccupied when all the following conditions are met:

- Time falls outside normal operating hours in programmed schedule (e.g., 7 AM to 7 PM);
- Dual-technology (e.g., a combination of passive infrared, microwave, or ultrasonic) occupancy sensors have adequate coverage and redundancy, and do not trigger reduced air-exchange rates within specified normal operating hours; and
- Hoods maintain their minimum settings (see Section 4.2.1: Chemical Fume Hoods Design).

4.1.4 ROOM PRESSURE

Room pressurization should be designed to minimize the movement of air from laboratory work areas of high potential contamination to areas of lower potential contamination (e.g., corridors). This may be accomplished by specifying supply/exhaust offsets (most labs) or room pressure differentials. Design must ensure adequate transfer air is available under operational conditions (e.g., all hallway doors closed) to ensure adequate makeup air for all exhaust equipment and operation of doors without excessive resistance. Air flow direction (or room pressure differentials) can be verified using smoke/fog generators (or using a micro-manometer), and should be specified on project documents (e.g., indicated by arrows).

4.1.5 ENTHALPY WHEELS

Enthalpy wheels are not permitted to be installed in any exhaust streams that include exhaust from laboratory fume hoods, gas cabinets or other type of ventilated enclosures (based on the potential to off-gas absorbed materials back into the air supply). Other types of energy recovery systems are recommended for laboratory ventilation systems (e.g., heat pipes, run-around loops). Enthalpy wheels may be used (and air supplied back to laboratories) if general lab exhaust is not connected to fume hoods or other ventilated enclosures.

4.1.6 DEMAND CONTROL VENTILATION

EH&S does not recommend the use of demand-controlled ventilation (DCV) systems in laboratory work areas for the following reasons:

- Contaminant concentrations at sensor locations do not correlate well with exposures at source and may be delayed. Local exhaust ventilation is the preferred method to control exposures.
- Materials and processes are constantly changing and no single sensor can assure detection of significant potential contaminants, so some contaminants may go undetected.

Laboratories or support areas with a few specific measurable contaminants (such as ammonia and particles in animal containment areas) driving ventilation rates may be appropriate applications for DCV, but must be reviewed on an individual basis.

DCV is recommended for any office/conference/meeting rooms, including those in a laboratory building.

4.1.7 LABORATORY EXHAUST

- Large installations or installations close to fresh air intakes or community receptors should be modeled to determine best locations and stack height needed for effective dispersion of contaminants.
- Laboratory exhaust ventilation shall meet the requirements in Section 2.2: HVAC Systems.
- Laboratory exhaust shall not be re-circulated, but discharged directed to the atmosphere. Air cleaning shall be performed when required to meet applicable federal, state or local air emission standard.
- Laboratory exhaust ducts in laboratory work areas shall be kept at negative pressure by installing fans outside of buildings, preferably on the highest level roof or in a rooftop penthouse or mechanical space designed for such use.
- Laboratory exhaust connections for future laboratory ventilation, such as laboratory extraction arms of bench top ventilated enclosures shall be included in design. Number, locations and duct sizes will determine based on project needs. All connections points shall be provided with dampers.
- All exhaust fans discharging directly to the atmosphere shall have an isolation damper installed at the inlet side. All exhaust fans discharging to a common stack or exhaust plenum shall have isolation dampers at both the inlet and outlet.
- Laboratory exhaust minimum discharge velocities shall be 3000 fpm unless demonstrated that specific design can meets dilution criteria at all potential receptors.

4.1.8 EMERGENCY CONTROLS

Laboratories using volatile hazardous chemicals shall be provided with a Purge Ventilation button.

4.2 LOCAL EXHAUST VENTILATION (EXPOSURE CONTROL DEVICES)

4.2.1 CHEMICAL FUME HOODS DESIGN

- All fume hoods shall be provided with a visual flow indicator and flow alarms.
- High performance hoods should be installed unless specific factors require higher flow rates. High performance fume hoods have design improvements (e.g., baffles/slots, airfoils, aerodynamic flow into and within the hood) that enable adequate containment with reduced airflow into the hood.
- Manufacturers must provide ASHRAE 110-2016 Methods of Testing Performance of Laboratory Fume Hoods as manufactured test results with control level of AM.0.05 as specified in section 6.1.2.7 of ANSI/AIHA-Z 9.5 Laboratory Ventilation-2012.
- For horizontally-sliding sash panels, provide at least one panel no more than 14 inches wide to enable hood users to wrap their arms around the panel as a safety shield (per ANSI Z9.5 paragraph 3.1.1.3).
- Automatic Sash Closers may be installed in order to improve sash management on VAV hoods. Automatic sash openers should be disabled unless specifically requested by user. Lab representative(s) should be informed if automatic sash closers are installed and be notified about any limitations on the use of the hood with this installation. Automatic sash closers should have the following features:
    - Include both a proximity and motion sensor to better evaluate hood status.
    - Sensor on sash to accurately detect obstacles, preferably with a recoil function that moves sash away from obstacle when detected.
    - Time-delays for sash closing should allow for delays up to 15 minutes.
    - Allow manual override of positioning with a force of no more than 10 pounds mechanical both when powered and during fault modes or power failures.
    - Occupancy sensors may be installed on VAV hoods as long as the unoccupied hood mode is activated

only if the sash is closed or if outside normal operating hours.

- Cup sinks in fume hoods are strongly discouraged by the local sewer authorities, and if installed should be equipped with a berm to prevent any chemical spills from entering the municipal sewer system. Consult with EH&S to confirm the process requirements or explore alternatives prior to installing new cup sinks in fume hoods, since the local sewer authorities have also indicated that they intend to prohibit cup sinks in the future and may then require that all existing cup sinks be capped.

Environmental Factors

High performance hoods, which operate at reduced average face velocity, are more sensitive to environmental conditions and may require different diffuser design/location than standard hoods. Laboratories with higher air-exchange rates also need careful attention to meet this requirement.

- Supply diffuser throw velocities aimed at a hood face shall not exceed one-half (preferably one-third) the fume hood capture velocity. This requirement may be met by location (e.g., six horizontal feet away) and/or design of supply diffusers (e.g., flow directed away from fume hoods).
- In small rooms where desired supply air diffuser location and/or velocity at face of hood cannot be maintained, use radial flow diffusers. These are high capacity outlets with short throws and one or two-way discharge patterns.
- Fume hoods should be kept away from high-traffic areas; and
- Fume hoods should not be located within six feet of doors (other than emergency-only exit doors).

Fume Hood Set Points

All measurements at Standard Operating Conditions (SOC) defined as sashes open 18 inches high for vertical-sliding or combination sashes, or the sash position with maximum open width for horizontal sash.

Note: Divide the opening into a grid and take 20-second average readings in the center of each grid rectangle, in order to calculate the AFV.

- Minimum Average Face Velocities (AFV) at SOC in feet-per-minute (fpm)
  - High Performance Hood: **70 fpm** (+/- 5 fpm)

- Standard Hood: **100 fpm** (+/- 10 fpm)

- Minimum Alarm AFV Set Points in fpm
  - High Performance Hood: **60 fpm**

Standard Hood: **80 fpm**

- Minimum Flow for VAV Fume Hoods in cubic-feet-per-minute (cfm)/square feet (sf)
  - **15 cfm/sf**

Note: Hoods should be programmed to maintain their minimum settings with sashes in closed position, or at least the 60 fpm (High Performance) or 80 fpm (Standard) face velocity at SOC in any labs that require controlled heated or chemical processes to run overnight).

Performance Testing

ASHRAE 110 as-installed testing should be conducted on all hoods, particularly for high performance hoods, installed in new locations; on large projects involving the installation of more than five hoods, particularly those in identical room configurations (e.g., identical alcoves, or environmental factors such as diffuser and door locations) on multiple floors with similar layouts, the number of hoods tested can be reduced to a representative number (e.g., at least one hood in each different layout, such as alcove/open room and distance from doors/diffusers). All fume hoods must meet acceptable control of AI 0.1 ppm unless otherwise specified**.**

Note: Conduct the ASHRAE 110 testing to challenge the hood at the alarm set point (i.e., the lowest point of the full range of operating exhaust conditions), then increase the exhaust to the design set point (i.e., middle of the range of operating conditions) after completing the testing. Include the sash movement containment test during the ASHRAE 110 testing.

For VAV hoods, confirm that: (a) that face velocity control (at 25% open, 18 inches open, and full open sash position) ensures flow stability within +/-10% of the hood manufacturer's design steady-state specification; and (b) response time (i.e., time to steady state) is less than 3 seconds after completion of the sash movement.

4.2.2 RADIOLOGICAL HOODS

In addition to the general design requirements for laboratory fume hoods, radiological fume hoods shall be made of type 304 stainless steel with coved seamless welded seams. Hoods used for Technetium-99 (with a half-life of 211,000 years) should not be manifolded with non-radioisotope hoods unless an activated charcoal bed filter is provided between the hood and manifold.

4.2.3 PERCHLORIC ACID HOODS

Any laboratories that will use heated perchloric acid in a process where perchloric acid vapors are not condensed (or otherwise trapped or scrubbed) as part of the process shall be equipped with an acid scrubber or perchloric acid hood.

Perchloric acid hoods where installed shall not be manifolded with non-perchloric acid hoods unless a scrubber is installed between the hood and manifold.

In addition to general design requirements for laboratory fume hoods, perchloric acid hoods shall meet additional design requirements as specified in section 87.112 of NFPA 45 -2015 Standard for Fire Protection for Laboratories Using Chemicals and section 3.2.54 of ANSI/AIHA Z9.5 Laboratory Ventialtion-2012.

4.2.4 GAS CABINETS

When Required

- Any amount of Highly Toxic Gas (GHS Cat 1 Acute Toxicity) must be stored in a gas cabinet or exhausted enclosure as per Table 60.4.2.1.1.3 of 527 CMR 1 Comprehensive Mass. Fire Code and Table 307.1(2) in the Massachusetts Building Code and Table 63.2.3.1.1 in Mass Fire Code.
- Any storage of toxic, flammable, oxidizing or pyrophoric gas in excess of MAQ Table 307.1(2) in the Massachusetts Building Code Table 63.2.3.1.1 in the Massachusetts Fire Code shall be stored gas cabinet or vented enclosure.
- Any container greater than 0.5 standard cubic feet containing Silane gas at concentrations > 1.37% shall be stored in sprinklered gas cabinet as per CGA 13-2006 Storage and Handling of Silane and Silane Mixtures.

Design

- Gas cabinets where required shall meet the MFC section 62.2.16.
- Exhausted enclosures shall meet the requirements of MFC 62.2.17.
- Gas cabinets where required containing silane or silane mixtures shall meet the requirements of CGA 13-2006 Storage and Handling of Silane and Silane Mixtures.

4.2.5 SNORKEL EXHAUST ARMS

- Snorkel Exhaust Arms shall be 75mm (3 inches) in diameter unless special conditions require additional flow capacity. Note that flexible ducts connected directly from equipment exhaust ports to the facility exhaust system are not considered Snorkel Exhaust Arms.
- Snorkel Exhaust Arm makes and models shall be Nederman FX Model or equivalent.
- These articulating arms may be made of aluminum unless specific conditions require additional chemical resistance or prevention of ESD (electrostatic discharge).
- Snorkel Exhaust Arm hoods may be made of transparent plastic unless specific anticipated conditions require heat resistance, additional chemical resistance, or ESD prevention. Examples of Snorkel Exhaust Arm hoods are as follows:
    - Nederman Combi Original (Model 70500144)
    - Nederman Flange Hood (Model 70502844) (if tight clearance on benchtop)
    - Nederman Metal Hood (Model 70500444) (for use as canopy hood for oven vents)
- Snorkel Exhaust Arms may be attached to bench top ventilated enclosures only if they are designed to do so and provide the flow specified for the enclosures to achieve an average velocity of 80-100 fpm across the face of the enclosure opening(s).
- The articulating arms shall be equipped with a shutoff damper at an accessible point of use that can be engaged when the exhaust flow is not needed.

4.2.6 CANOPY HOODS

- Canopy hoods should be designed with telescoping, articulate or flexible exhaust arms (e.g., aluminum or stainless steel depending on the vented air temperature), steel flange extensions, or other means to enable the bottom of the metal hoods to be adjusted to a height no more than 3-6 inches above the specific heated source (e.g., oven or furnace vent).

- The edge of each canopy hood should project at least 3 inches outside the boundaries of the heated source.

4.2.7 BIOSAFETY CABINET VENTILATION AND DUCTING REQUIREMENTS

- Class II Type B1 cabinets must be hard ducted, and Class II Type B2 cabinets are total exhaust. These cabinets should only be installed if a risk assessment of the research supports it as the ventilation requirements for these cabinets are quite strenuous on a building's HVAC system.
- Class II Type A2 installations must comply with requirements for design, construction, and performance contained in NSF/ANSI 49- 2010.
- Venting a Class II Type A2 cabinet to the outside may be achieved by canopy or thimble connection. **Class II Type A2 BSC may not be hard ducted to the building exhaust system**.
  - Canopy connection of these cabinets allows for the use of small volumes of volatile chemicals or radioactive materials. The canopy/thimble connection does not allow for the same chemical use as in a chemical fume hood or in a hard ducted Class II Type B BSC.
  - Cabinets should only be retrofitted to a canopy connection with available manufacturer conversion kits or a custom fabricated canopy connection if necessary. Note that the exhaust volume for canopy connections is slightly higher and the design of the canopy is critical to the performance. For older model BSCs that cannot accept a canopy connection, and the research involves the use of volatile reagents in the cabinet, cabinet replacement should be considered.
  - To exhaust a Class II Type A2 BSC, canopy (thimble) ducting is required and an airflow monitor in the exhaust duct with an audible and visual alarm is required.

4.3 GENERAL DESIGN REQUIREMENTS FOR BIOLOGICAL RESEARCH LABORATORIES (BL1 AND BL2)

BL1 and BL2 are the most commonly found biological research laboratories at Harvard. Design of biological research laboratories at Harvard must comply with the NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines). Additional information about biosafety levels, biological agents and laboratory design elements may be found in the CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (5th edition).

4.3.1 DESIGN

Mechanisms for controlling laboratory access must be in place. All laboratories must have doors for separation from public areas. The doors must be self-closing and lockable in order to control access to the laboratory and to research materials and information. Locking mechanisms on doors may include a standard keyed entry, a punch-code lock, a card reader, or a combination of these measures. Card readers are preferred.

- Biological research laboratories should be designed for easy cleaning and decontamination. This includes built-in components as well as furniture.
- Bench tops must be impervious to water and resistant to acids, alkalis, organic solvents and moderate heat.
- Laboratory furniture should be sturdy and easily cleanable. Upholstered or cloth coverings on any furniture are not allowed. Hard, non-porous surfaces, like plastic are more easily cleaned and decontaminated. Spaces between benches, cabinets, and desks should be easily accessible for cleaning.
- Carpets, rugs, or fabric window coverings are not appropriate in research laboratories.
- Biological research laboratories must have net directional inward airflow (be under negative pressure) with air moving from public spaces into the laboratory towards the most contaminated or high risk areas. This allows for control of exposures in case of a spill in the laboratory. Laboratory air may not be recirculated to any other building spaces outside of the laboratory. It must be exhausted to the outside.
- Eating and drinking are not permitted in laboratories. Laboratory design should incorporate areas outside the labs to store food and a safe place to eat.

4.3.2 SINKS

Sinks for hand washing are required in each biological research lab as well as eye wash stations. The following considerations should be made when choosing a sink:

- Hands-free sinks (IR sensors or foot-pedal operated) are preferred since this reduces spread of contaminants from handles.
- Otherwise, consider use of paddle handles to minimize need to touch handles to turn water on and off.
- Sink screen strainers (fine mesh) should be considered to prevent sharps, i.e., needles, small pipette tips from going down the drain.
- Sink material should be compatible with chemical decontaminants commonly used in biological laboratories. They should be easy to clean and disinfect.

Note: Higher containment laboratories have specific sink requirements.

4.3.3 PEST CONTROL

Laboratories should be designed to prevent insect and/or rodent penetration, including sealing holes to prevent intrusion. If laboratory windows open, they must be fitted with fly screens.

4.3.4 ADDITIONAL CONSIDERATIONS

Depending on the research and safety needs, laboratories may require the following equipment:

- Biological safety cabinets (Refer to Biological Safety Cabinets for more details).
- Autoclaves (Refer to the Autoclave section for more details).

4.3.5 REFERENCES

NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules, 2013. CDC/NIH Biosafety in Microbiological and Biomedical Laboratories, 5th Edition, 2009.

4.4 LABORATORY EQUIPMENT AND PROCESSES

4.4.1 DUCTLESS FUME HOODS

- Ductless fume hoods could be used only if processes conducted within the hoods are highly repetitive (e.g., in core facilities that use the same limited number of chemicals at the same concentrations with few anticipated changes over the life of the hood), after review by EH&S.
- Ductless hood shall meet the requirements of Section 4.2 of ANSI/ASHRAE Z9.5 Laboratory Ventilation.
- Ductless fume hoods manufacturers shall meet a list of allowed contaminants and concentrations used in the specific lab.
- Ductless fume hoods shall include a reliable monitoring system which will indicate breakthrough at no more than one-half the TLV.
- Ductless fume hoods shall pass ASHRAE 110 at specified velocities.

4.4.2 GAS DETECTION AND ALARMS

Laboratories using highly toxic gases (GHS Cat 1 Acute Toxic) in quantities greater than MAQ must be equipped with gas detection and alarms.

4.4.3 BIOSAFETY CABINETS

The Biosafety Cabinet (BSC) is a primary containment device in the laboratory, used to prevent airborne exposure to infectious materials and contamination of sterile products during manipulations. The choice of BSC type should be made in consultation with EH&S. The following shall be considered when selecting an appropriate BSC:

- Risk Group (RG) of agent to be used,
- Level of protection required for work,
- Use of volatile chemicals,
- Type of procedures performed,
- Type and size of equipment that will go inside the BSC, and

- Handicap accessibility.

Classes of Biosafety Cabinets

Class/Type	Personnel Protection	Product Protection	Application
Class I	Yes	No	Uncommon. Exhaust is often discharged to the outside. Exhaust is High Efficiency Particulate Air (HEPA) filtered.
Class II, Type A1	Yes	Yes	HEPA filtered exhaust is recirculated into the room or discharged to the outside via a canopy connection. Not suitable for work with volatile toxic chemicals or radionuclides.
Class II, Type A2	Yes	Yes	Most common BSC found on campus. HEPA filtered exhaust is recirculated into the room or discharged to the outside via canopy connection. May be used for small amounts of volatile toxic chemicals and trace amount of radionuclides if exhausted to the outside via canopy connection. This cabinet may **not** be hard ducted to the exhaust system.
Class II, Type B1	Yes	Yes	HEPA filtered externally hard ducted exhaust with high energy demands. May be used for low levels of volatile toxic chemicals and trace amounts radionuclides.
Class II, Type B2	Yes	Yes	HEPA filtered externally hard ducted exhaust with energy demands. May be used for work with volatile toxic chemicals and radionuclides.
Class III	Yes	Yes	Manipulation of highly-infectious pathogens. Ducted closed system. Enclosed, gas-tight system.

Installation of Biosafety Cabinets

- Location/placement:
  - Install away from doors and high traffic pattern,
  - Do not locate directly underneath the room air supply air diffuser or return,
  - Do not locate directly opposite a chemical fume hood or a BSC,
  - Install away from equipment that generates steam or moisture,
  - Install away from operable and unlocked windows, and
  - Ensure that the room has mechanical exhaust ventilation in addition to exhaust ventilation provided by a hard ducted BSC.
- Ducting installation may require hard or canopy connections. Installation should follow the manufacturer's specifications.
- Provide enough ceiling height clearance to prevent the exhaust from disrupting the barrier at the access opening of the BSC.
- Locate the power receptacle high on the wall for ease of access in unplugging.

BSC Accessories and Customization

There are many manufacturer options available in purchasing or customization of a BSC. Options available include installation with inline gas and vacuum nozzles, UV lights, Sash alarms, and built-in containment for an aspiration flask set-up, etc. For BSCs with energy efficiency monitors, an electrical outlet should be installed at or near the top of the BSC.

It is recommended investigators do NOT use Bunsen burners, including the "touch type", or other heat sources while working in a BSC. Therefore, new BSCs should not be installed with plumbing for gas lines into the cabinet.

Certification of Biosafety Cabinets

- Newly installed BSC shall be tested and certified prior to use and with each move or repair.

- The BSC that fails certification shall not be used until it is fixed. It must subsequently pass a recertification test prior to use.
- Testing and certification of Class II BSC shall meet current National Sanitation Foundation (NSF) *49 Standard for Class II Biosafety Cabinets*.

Aerosol Generation Equipment

Common aerosol generation equipment in biological research laboratories are sonicators, Madison Aerosol Chambers, and Fluorescence Activated Cell Sorting (FACs). This is not an inclusive list as other laboratory equipment may also generate smaller amounts of aerosols. However, these classes of equipment carry the risk of significant aerosol generation and require special consideration for control of release of aerosols during operation.

Examples to reduce aerosols from equipment:

- Placing the equipment within a Biosafety cabinet or specially designed HEPA filtered laminar airflow cabinet designed to contain aerosols.
- Design special containment equipment specific to the instrument
- Purchase the aerosol containment devices for the machines if available.

4.4.4 EMERGENCY EYEWASHES AND SHOWERS

Every newly constructed or renovated laboratory or any room used for similar purposes wherein corrosives or flammable liquids are handled or where open flame devices are used, shall be equipped with one or more Emergency Eyewashes and Showers (Commonwealth of Massachusetts Comprehensive Fire Safety Code - 527 CMR 1.00 Section 10.24), located no greater than 50 feet from where corrosive or flammable liquids are handled.

The Occupational Safety and Health Administration - 29 CFR 1910.151(c) requires, “where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use.”

Work areas and operations that may require these devices include mechanical rooms, bio- hazardous waste rooms, radioactive materials use/waste areas, pH neutralization system locations, battery charging areas, spraying operations, high dust areas, etc.

All emergency eyewashes and showers shall be installed in accordance with ANSI, Z358.1-2014. ANSI states that emergency eyewash and shower equipment shall be in accessible locations that require no more than 10 seconds to reach, located on the same level as the hazard, and the path of travel shall be free of obstructions that may inhibit its immediate use.

The "10 second" rule may be modified depending on the potential effect of the chemical. Where a highly corrosive chemical is used, an emergency shower and eyewash station may be required within 3 meters to 6 meters (10 feet to 20 feet) from the hazard. These units should be installed in such a way that they do not become contaminated from corrosive chemicals or other contaminants used nearby.

Selection of Emergency Eyewashes and Showers: All Emergency Eyewashes and Showers shall comply with *ANSI, Z358.1-2014*.

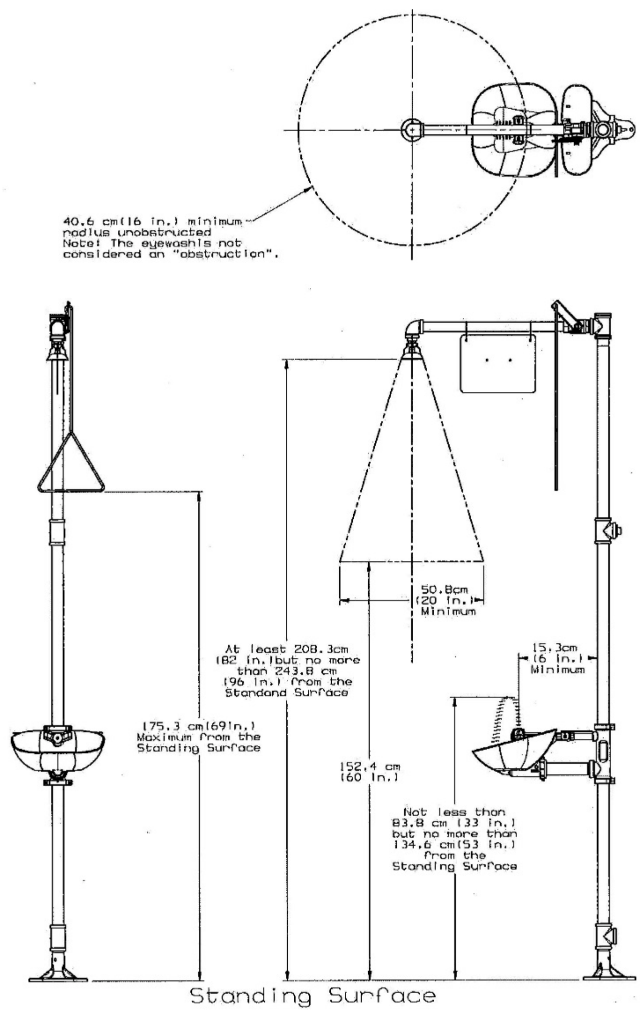
Emergency showers minimum volume of spray should be 75.7 liters/minute (20 gallons/minute) connected to an uninterruptible water supply. The shower should also be designed so that it can be activated in 1 second or less, and it remains operational without use of the operator's hands.

Eyewash stations must be easily activated, deliver fluid to both eyes simultaneously at a volume of not less than 1.5 liters/minute (0.4 gallons/minute) for 15 minutes, and remain operational in a hands-free mode. However, the volume should not be at a velocity that may injure the eyes. The eyewash and its actuator shall not conflict with other operating controls (e.g., hot, cold, or RO water) and not be blocked by casework or other obstructions.

Combination eyewash drench hose units that are third-party certified to meet or exceed the provisions of ANSI, Z358.1-2014 are useful in areas where relatively small quantities of injurious materials are handled.

Drench Hose: NOT permitted as

primary emergency eyewash/ shower



Preferred Combination Eyewash/Shower

The ANSI standard for water temperature recommends that the water be "tepid". In general, water temperatures in the range 16°-38°C (about 60°-100°F) are considered suitable, with temperatures in the higher part of the range if extended periods of eye irrigation or showering are required.

Floor drains must be provided on all fixed eyewash stations and showers. Traps to the floor drains should consider “U” type or primed P - traps.

In an emergency situation, one’s vision may be impaired. Therefore, such emergency equipment requires what ANSI/ISEA describes as a “highly visible sign.” In accordance with 527 CMR 1.00 Section 10.24, the sign shall be of contrasting color, either red and white or green and white. The sign shall be at least 70 square inches in area, bearing the words “EMERGENCY WASH STATION” or “SAFETY SHOWER”. This sign must be in close proximity to the emergency equipment for quick identification. Adequate lighting must also be provided in the area surrounding emergency equipment.

4.4.5 BIOLOGICAL/BIOMEDICAL WASTE STORAGE FACILITY

Storage and disposal of biological waste from laboratories must be in accordance with the 105 CMR 480.000 Storage and Disposal of Infectious or Physically Dangerous Medical or Biological Waste State Sanitary Code Chapter VIII. Considerations should be made when designing a waste storage area for temporary storage of biological waste.

- The storage facility should be away from access areas,
- The size of the storage facility should be based on the number of laboratories and the amount of waste each laboratory would generate,
- The facility should be dedicated for storage of biological/biomedical waste,
- An exhaust system should be available to vent odor,
- Walls, floor and ceiling should have surfaces that are easily cleaned and decontaminated,
- Wall, floor and ceiling penetrations should be sealed (rodent & bug tight),
- The door should be lockable,
- Biological/biomedical waste boxes should be stored on top of pallets, and

- A biohazard door placard should be posted on the outside of the door.

In addition to the previous considerations, the following issues should also be addressed as necessary:

- Temperature control for storage of animal parts and carcasses.
- Installation of a berm to prevent release of liquid spills outside the storage room.
- Accessible handwashing facility.
- Accessible closet to store materials for use in routine cleaning and decontamination of storage facility.

4.4.6 CHEMICAL/HAZARDOUS WASTE MAIN ACCUMULATION AREAS (MAA)

Prior to setting up a MAA; contact Kathryn Kaminski or Lance Schumacher at EH&S.

Compliance/technical requirements for Hazardous Waste Main Accumulation Areas are prescribed in DEP regulation - 310 CMR 30 and the relevant fire code. These requirements include but are not limited the following:

Location

All lab buildings must be equipped with at least one MAA that is sized to be able to store chemical waste from the building for the appropriate time frames (90 days for large quantity generators, 180 days for small quantity generators).

- If the MAA will be used to store ignitable or reactive hazardous waste, then the room must be located 15 meters from the property line.
- If the MAA will be used to store class 1 flammable materials then the room must be located at grade (no below grade storage of Class 1 flammables is permitted).
- If the loading dock is not at the same level as the MAA, then elevator access to the loading dock is required. From a perception standpoint, a separate service elevator should be available in the building for moving hazardous waste between the lab floors, the MAA, and the loading dock so that lab staff and visitors do not find themselves riding the elevator along with drums or carts full of hazardous waste. Generally flammable waste can be stored in the MAA at grade and loaded at a loaded dock below grade

without issue.

Segregation/Aisle Space

Area must be set-up to ensure that waste containers are adequately segregated with appropriate secondary containment. In addition, there must be enough space to ensure adequate aisle space for egress (3 feet). Virgin chemicals must be stored separately from hazardous waste.

Containment

The floor of the room must be sealed (typically epoxy-sealed) to eliminate all cracks and gaps and a berm or other secondary containment method installed so that spilled material could not escape the room. The containment system (floor/containment vault) must be able to hold at any time 10% of the total volume of liquid hazardous waste in the area or 110% of the largest container and/or the volume of water that would be accumulated during an event where the sprinkler system is discharged in the room. There can be no sewer floor drains in the room.

Fume Hood

A fume hood would be necessary to store special high hazards wastes that may present volatility hazards. In addition, fume hood will also be used to perform fingerprint analysis on unknown waste streams. If possible, the room should also include a consolidation area for 55-gallon drums with ventilation, bonding, and grounding suitable for flammable waste consolidation.

Ventilation/Bonding/Grounding

Ventilation System: The system should be designed to adequately address potential volatile emissions in area. The system should be stand-alone system such that fumes from a spill in the area would not be carried to the rest of the building.

Walk in drum hood or other local ventilation should be designed and installed with appropriate bonding and grounding to allow for consolidation of flammable waste

Emergency Equipment

The area must be equipped with the following equipment:

- Telephone: Able to call an outside emergency agency (e.g., fire dept.) - must be outside of the area where the waste is being stored.
- Fire Control Equipment: Fire extinguisher, intrinsically-safe lighting and special fire control equipment (i.e., fire extinguishing system appropriate for wastes stored in area - typically inert gas).
- Emergency shower and eye wash.
- Spill equipment
- Shelving: Stable, heavy duty metal shelving as applicable for waste types and volumes to be stored in the room.
- Storage room for carts, drums and emergency response spill supplies.
- Security considerations:
  - Doors to area must be fire rated and equipped with locks or keycard access to prevent unauthorized entry of untrained individuals.
  - There should be no windows in doors or walls where the public would be able to view hazardous waste
  - If windows are present waste would need to be located inside of a cabinet and/or out of view of the public
- Emergency Egress Map: Required by the Hazardous Waste Contingency Plan identifying spill kit and phone location etc.
- Exit Signs must be posted at all exit ways from the area.
- No Smoking Signs

Desk Space

A suitable secure workspace should be provided that is near but not in the chemical waste storage room and also has a separate means of access and egress. Preferably, the workspace would be in an adjacent room with a window where the storage room could safety be viewed through the window to assess potential hazards without having to access the storage room.

4.4.7 FIRE EXTINGUISHERS FOR SENSITIVE ELECTRONIC EQUIPMENT

Provide a hydrofluorocarbon (HFC) clean agent portable fire extinguisher (e.g., ANSUL CleanGuard HFC-236fa) with at least 9.5 pounds of extinguishing agent in the immediate vicinity of the sensitive electronic equipment (e.g., laser cutters, Class 3B or 4 lasers, epitaxial reactors, clean room environments, etc.).

A phased approach is possible for equipment where signage and instructions for lab personnel and a maintenance program for the extinguishers are implemented: provide a CO2 (Class BC) extinguisher in the immediate vicinity of the sensitive electronic equipment and ensure that a Class ABC extinguisher is accessible nearby as a second line of defense.

Rationale: Typical Class ABC extinguishers are effective but could damage sensitive electronic equipment. HFC and CO2 extinguishers leave less residue on such equipment. Portable extinguishers with CO2 or less than 9.5 pounds of ANSUL CleanGuard HFC-236fa extinguishing agent (both rated Class BC) are not rated for combustibles such as paper, wood, cloths and some plastics (Class A). CO2 extinguishers may at times not displace enough oxygen to totally extinguish the flames and could elicit a mild static shock if their metal braid is damaged.

4.5 INDUSTRIAL WASTEWATER PRETREATMENT SYSTEMS

An industrial wastewater pretreatment system (IWPS) shall mean a system designed to remove pollutants below and/or otherwise treat industrial wastewater to a point where the wastewater discharged to the MWRA collection system (or other sewer authority as applicable) is in compliance with Harvard's respective wastewater discharge permit.

For the purposes of the specification referenced as follows, only pH neutralization has been included. For systems requiring additional treatment technologies to achieve compliance (i.e., metals removal), amendments to this specification will be required.

General Performance Requirements

The IWPS shall at least be capable of the following:

- Maintaining effluent discharge between 5.5 and 12.0 pH per MWRA or as required by the local authority,

- Maintaining pH by means of automatic control using feedback from installed electronic pH sensors (preferably all operations would be fully automated, see definition in reference document),
- Sending pH and/or other critical alarm conditions to the building management system which can then be relayed to another location (i.e., Harvard University Operations Center), and
- Continuously measuring and recording effluent pH and flow on a circular pH chart recorder or approved equivalent method.

For specific information on design of IWPSs refer to the Harvard EH&S Industrial Wastewater Laboratory Wastewater Pretreatment Systems Specification.

4.6 LAB PEST CONTROL

- Labs engaged in biological or nanotechnology research including animal/plant transgenic, clean room research and infectious disease research should be designed to eliminate arthropod (includes mites and insects) or other pest infestations.
- When drop ceilings are installed, the ceiling space above the tile field shall be sealed from rodent entry. All holes and penetrations shall be sealed with fire stop material.
- Hollow core doors to animal rooms shall not have gaps at the base that would allow mice entry into the door void space.
- If a laboratory or other animal facility requires an arthropod tight construction, then contact the Pest Control Office at EH&S for a detailed review and assessment.
- Minimize the number of floor drains and sinks in a facility.
- Specify animal cages that contain sealed tubing so that arthropod pests do not become transported by carts and cages throughout a facility.
- If exit doors lead to the exterior, consider designing the space to accommodate electric fly light traps.
- Refer to EH&S Standard Specs – Pest Control 015716 on IPM for research facilities.

5.0 MAKERSPACE FACILITIES

The following are minimum setup requirements for makerspace facility equipment.

5.1 LASER CUTTER VENTILATION AND FIRE SAFETY PRECAUTIONS

- Provide compressed air for an air assist system that either comes with or is added to the laser head, designed to remove smoke and debris in the path of the laser.
- Connect spark arrester in exhaust stream directly downstream of laser cutter.
- Connect further downstream one of these following equipment options (listed in order of decreasing preference):
    - A booster/inline fan to direct the exhaust to building roof; or
    - A filtration unit, which discharges to a direct or thimble connection to building exhaust with about 10% more cfm than exhausted from the filtration unit.

    Rationale: Laser cutters typically require connection to exhaust fans that can draw ~ 500 cfm at ~ 6 inches w.c. static pressure (check manufacturer specifications for exact requirements). This prevents particles from settling within the cutter, which would degrade the cutter performance and that could potentially catch fire. The filtration unit consists of a fan that can handle the volumetric flow rate and static pressure requirements, pre-filter, HEPA filter and charcoal filter; however, the charcoal filter can become saturated and be bypassed fairly quickly, so the backup direct or thimble connection to the building exhaust system is necessary.
- Provide mechanism to turn on exhaust only to specific laser cutter in use.
- Provide mechanism to prevent laser cutter from turning on if exhaust is off and provide alarm for loss of exhaust during laser cutter operation, especially if there are no visible or audible indications that the exhaust equipment selected above is off (e.g., if the equipment is in a noise-dampening enclosure or remote location).

  Rationale: The user needs to be alerted to initiate a shutdown process to enable an adequate cooling down time, instead of automatically cutting off the laser cutter power.
- Provide the fire extinguishers for sensitive electronic equipment specified in Section 4.4.7: Fire

Extinguishers for Sensitive Electronic Equipment.

- Follow the other laser system design, construction and registration guidelines specified in Section 2.6: Laser Systems.

5.2 3D PRINTER VENTILATION GUIDELINES AND SAFETY PRECAUTIONS

5.2.1 GENERAL GUIDELINES

- Provide ventilation that can be manually or electronically switched on when the 3D printers are operated for printers that do not have an integrated enclosure and well-designed filtration system with specifications for changeout schedule. Examples of ventilation controls could include single unit local exhaust ventilation system such as snorkel fume extraction arms or for situations where multiple printers are used, operating 3D printers on enclosed ventilated racks.
- Ventilation options (in order of decreasing effectiveness) include:
  - Directing exhaust outdoors;
  - Connecting the enclosure to a HEPA and activated charcoal filtration unit (with specified changeout schedule that avoids breakthrough); or
  - Increasing the room ventilation to at least 4 to 6 air changes per hour (ACH), only if at most two 3D printers are concurrently operated, the 3D printers are not operated in the immediate vicinity of a workstation occupied by personnel, and the 3D printers are preferably placed near room exhaust grille(s).
- Provide a shelf or staging area for food and drink to be kept outside the 3D printing area.
- Corrosive baths associated with 3D printers can produce strong odors and eye irritation. Ensure that room ventilation or local exhaust ventilation is designed to adequately address these hazards. Ensure that an eyewash station is located nearby and flammables storage capacity is provided as needed (e.g., for storing isopropyl alcohol squeeze bottles). Ensure that the room is not carpeted.

5.2.2 PRINTER-SPECIFIC SAFETY PRECAUTIONS

Desktop FDM (Fused Deposition Modeling)

Provide local exhaust airflow (options noted in previous general guidelines) near non-enclosed printers. ABS or other similar polymers in particular require such exhaust ventilation. Do not position printers in an area where people will be located for an extended amount of time.

Professional level FDM

- Direct ventilation may not be necessary for some brands that have integral filtration provided by the manufacturer.
- Preferably select any available options that avoid the use of sodium hydroxide baths.

Desktop SLA (Stereolithography) or Polyjet

- Provide ventilation and flammables storage for the rinse bath.
- Ensure that space is provided for proper personal protective equipment (PPE) (e.g., gloves, lab coats, safety glasses) for handling uncured resins.
- Provide a layout/setup where the resin won't contaminate other items in the lab or segregate these machines to not be fully accessible to all users.

SLS (Selective Laser Sintering)

- While particulate emissions from SLS printers could be controlled inside a closed inert gas system during the print cycle, particulate emissions can occur during filling, leveling, staging, filter changes and clean-up. Ensure that the 3D printing area is equipped to manipulate materials such as fine powders through the entire process lifecycle.

ARCHITECT/DESIGNER ACKNOWLEDGEMENT

I, ______________________________________, a ____,
Architect/Designer Name *Architect/Designer Title*

at________________________, confirm that I have read and understand the issues outlined in this document.
Architect/Designer Firm

Further, I will ensure that the applicable conditions detailed in this document are incorporated by my company and/or any sub-consultants working under our direction into the design submittals that are required under the AIA B151, Abbreviated Standard Form of Agreement Between Owner and Architect, or other similar design contract, which I have executed with the University. I understand that as a condition of AIA B151 (or other executed design contract), all Architects and all Architect's consultants are required to provide design services in accordance with all current laws, statutes, ordinances, building codes, rules and regulations applicable to the design of a project. I also understand that this manual provides some additional background on certain design requirements that relate to environmental, health and safety (EH&S) issues. This manual does not address and is not intended to abrogate or assume responsibility for the duty to know and understand all governing requirements in accordance with AIA B151 (or other executed design contract). Rather, it is provided solely to communicate certain EH&S design issues that may be overlooked during the design of a University project.

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Company Name

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Authorized Signing Authority (print name)

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Authorized Signing Authority (signature)

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Date