



HARVARD UNIVERSITY
EH&S 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, typically the AIA B151, *Abbreviated Standard Form of Agreement Between Owner and Architect*. 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 AIA B151. 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

The EH&S tools and resources that have been developed for the above issues can be found at the EH&S website at:

<http://www.uos.harvard.edu/ehs/caps.shtml>



2.0 GENERAL DESIGN CONSIDERATIONS

2.1 Safety

2.1.1 Confined Spaces

All structures shall be designed in an effort 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:

- (1) Contains or has a potential to contain a hazardous atmosphere;
- (2) Contains a material that has the potential for engulfing an entrant;
- (3) 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
- (4) 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).

2.1.2 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 6 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.
- 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 ANSI standard *A1264.1-1995*.

2.1.3 Fixed Ladders

Where it is necessary to install a fixed ladder, it shall comply with the Occupational Safety and Health Administration standard *29 CFR 1910.27*. It shall also be constructed in accordance with ANSI standard *A14.3-2002*. 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, in order to minimize personal injuries.

2.1.4 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.

2.1.5 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 Engineer's (ASME) standard *A 120.1-2001* and *ASME 120.1b- 1999*.

2.1.6 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 - *527 CMR 10.00 - Fire Prevention, Section 10.02 Fire Extinguisher Section (2)*).



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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 to The American National Standards Institute (ANSI), Z358.1-2004. ANSI states that "emergency eyewash and shower equipment shall be located on the same level as the hazard, have un-obstructed access, and require not more than 10 seconds to reach."

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 - 6 meters (10 - 20 ft) from the hazard. These units should be installed in such a way that they do not become contaminated from corrosive chemicals used nearby.

Selection of Emergency Eyewashes and Showers: All Emergency Eyewashes and Showers shall comply with ANSI, Z358.1-2004.

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 less than 1 second, and it remains operational without the operator's hand on the valve (or lever, handle, etc.).


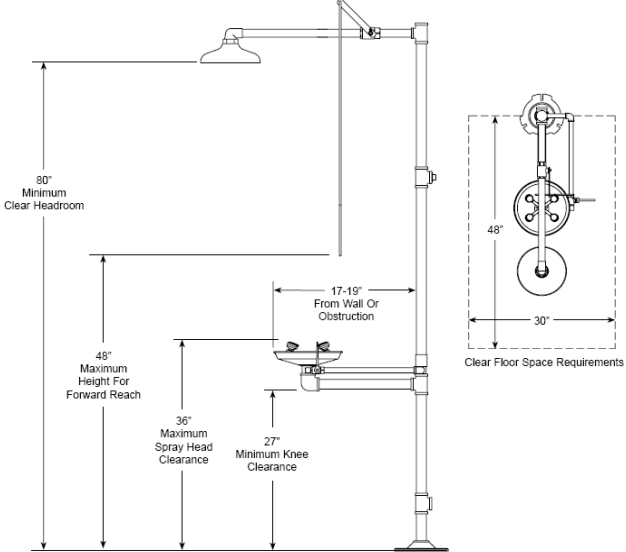
Eyewash stations must deliver fluid to both eyes simultaneously at a volume of not less than 1.5 liters/minute (0.4 gallons/minute) for 15 minutes. However, the volume should not be at a velocity that may injure the eyes.

Combination eyewash drench hose units that are third-party certified to meet or exceed the provisions of ANSI, Z358.1-2004 are useful in areas where relatively small quantities of injurious materials are handled.

The ANSI standard for water temperature recommends that the water be "tepid". In general, water temperatures in the range 27°-35°C (about 80°-95°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.



| Drench hose – NOT permitted as primary emergency eyewash/shower | Preferred Combination Eyewash/Shower |
|---|--|
|  |  |

2.2 Heating Ventilation and Air Conditioning Systems (HVAC)

2.2.1 Local Air Quality

A survey of the building site shall be conducted during periods of normal occupancy to identify potential pollutant sources in or around existing and/or proposed buildings or structures to identify particular potential pollution sources including vehicular traffic, loading docks, existing exhaust outlets, trash compactors, dumpsters, etc.

2.2.2 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 780 CMR 1208 and American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) 62.1-2004 section 5.1. HVAC systems shall provide ventilation meeting the minimum ventilation requirements to all occupied areas as specified in ASHRAE 62.1 – 2004, *Ventilation for Indoor Air Quality*. Variable Air Volume (VAV) systems with fixed outdoor damper positions must meet these requirements at minimum supply airflow.

2.2.3 Air Classification and Recirculation

Recirculation of return, transfer or exhaust air must meet the requirements of ASHRAE 62.1, Section 5.17. Vented air defined by ASHRAE as Air Class 4 shall not be recirculated. The following are considered to be Air Class 4 exhaust: laboratory fume hoods, gas cabinets,



chemical storage rooms, paint spray booths, commercial kitchen grease hoods, ducted biosafety cabinets and diazo printing equipment. Any potential Air Class 4 sources not listed in ASHRAE should be evaluated by Harvard University's Environmental Health and Safety department.

2.2.4 Thermal Comfort

Mechanical systems, controls, and thermal envelopes shall be designed so they are able to maintain thermal conditions, including temperature, humidity and airspeed, within ranges specified by *ASHRAE 55 – 2004, Thermal Environmental Conditions for Human Occupancy* under all combinations of expected conditions of internal heat load and external weather conditions. These performance criteria shall be documented in the design phase and verified during the commissioning of the HVAC system.

2.2.5 Building Pressurization

Design minimum outdoor air intake shall be greater than design maximum exhaust airflow to prevent infiltration of outside air particularly during the cooling season. Room or zone pressurization should be designed to prevent movement of air from more contaminated to less contaminated areas.

2.2.6 Noise and Acoustical Insulation

HVAC systems noise levels shall meet Room Criteria (RC) noise levels specified as per *ASHRAE 2003 HVAC Applications Handbook, Chapter 47 Sound 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.

2.2.7 Internal Fiberglass Duct Liner

Avoid the use of fiberglass board or coated fiberglass mat that is fastened or adhered to internal duct services. Specifically, internal fiberglass liner shall not be used in outside air intake duct, or between the supply fan cooling coil and terminal boxes. Minimize liner in the return air duct. Terminal boxes should be insulated with fiberglass with a hard cleanable surface exposed to the air stream. High security occupancies may mitigate cross talk noise between offices or other rooms with the use of interior lined duct downstream of the terminal box.

2.2.8 Air Intakes

Air intakes shall be provided with easily cleaned screens and drains to allow for the delivery of clean dry air to the HVAC system. Bird screens shall be provided to keep birds, leaves and other material out of the system. Design shall prevent rain or snow entry into HVAC system. Design shall meet the requirements of *ASHRAE 62.1-2004, Section 5.6, Outdoor Air Intakes*.

The location of outdoor air intakes shall meet the requirements of *780 CMR 2801.2.2.1, Location of Outdoor Air Intakes* Massachusetts Building Code (MBC) or *ASHRAE 62.1 –2004 Section 5.6.1*, whichever is most restrictive. The preferred location is on a roof top or high up on the prevailing wind side of building away from pollutant sources such as exhaust outlets from laboratory fume hoods, toilets and kitchens.



2.2.9 Filtration

All outdoor air must be filtered upstream of cooling coils or other wetted surfaces. Use filters with a minimum Minimum Efficiency Reporting Value (MERV) of 6 per *ASHRAE 52.2 1999, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*. See Table 3 page 24-11 in *ASHRAE Handbook-HVAC Systems and Equipment* for suggested 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.

Filter frames should be constructed of non corrosive materials. Filters shall be seated so as to provide no gaps. Filters shall be protected from rain water and a build-up of snow and ice. A permanent ladder and catwalk should be provided for filter banks greater than 6 feet tall to allow for inspection and maintenance.

Filter plenums shall have drains to allow for wash down. Plenum floors shall be waterproof and sloped ¼ inch per foot to floor drains. Each plenum with a drain should have a hose bib. Filter rack should be built on a 6 inch concrete curb when constructed on concrete floor.

2.2.10 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.

2.2.11 Drain Pans

Drain pans shall be provided beneath all dehumidifying cooling coil assemblies and all condensate producing heat exchangers. Drain pans shall meet design requirements of *ASHRAE 62.1, section 5.11, Drain Pans*.

2.2.12 Exhaust Ventilation

Minimum general mechanical exhaust ventilation shall be provided as recommended for select occupancies in *ASHRAE 62.1 –2004, Table 6.4. Minimum Exhaust Rates*. Refer to the manufacturer's specification on local exhaust ventilation for laboratory fume hood, gas cabinets and other specialized local exhaust ventilation.

Exhaust outlets and vents shall meet minimum distance requirements from air intakes as specified in *780 CMR 2801.2.2, Location of Air Intakes and Outlets of Mass Building Code(MBC)* or *ASHRAE 62.1 –2004, Appendix F, Separation of Exhaust Outlets and Outdoor Air Intakes*, whichever is most restrictive.

Exhaust outlets and vents shall meet minimum distances from windows as specified in *MBC 2801.2.2.3*. Exhaust shall be directed upward and be unobstructed by fixed rain cap or other design feature.

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.



2.2.13 Access Panels

Access panels and equipment clearance should meet all requirements of *ASHRAE 62.1, section 5.14, Access for Inspection, Cleaning and Maintenance.*

2.2.14 Dehumidification

HVAC systems with dehumidification capacity shall meet the requirements of *ASHRAE 62.1-2004 Section 5.10, Dehumidification Systems.*

2.2.15 Humidifiers & Water Spray Systems

Humidifiers and water spray systems shall meet the requirements of *ASHRAE 62.1-2004, Section 5.13.* Only potable water or a source with equal or better quality shall be used to provide water or steam to these systems. Avoid re-circulating designs that reuse spray water.

2.2.16 Fin-Tube Coils & Heat Exchangers

Fin-tube coils and heat exchangers shall meet the requirements of *ASHRAE 62.1-2004, Section 5.12.* Copper tubes and fins are preferred to aluminum, which will oxidize and degrade. Any parts constructed of aluminum must have anticorrosion coatings applied.

2.2.17 Building Envelope & Interior Surfaces

Building envelope and interior surfaces shall meet the requirements of *ASHRAE 62.1, Section 5.15.*

2.3 Air Emission Sources

2.3.1 Permitting

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 – 2.3.4 below. In addition, certain air emission sources that exceed a specified regulatory threshold require permitting and/or plan review from the Massachusetts Department of Environmental Protection (DEP) prior to installation. These thresholds are defined below and if your project involves one or more of these permitted sources, then a qualified air emission consultant must be retained as described in the EH&S website at:

http://www.uos.harvard.edu/ehs/caps_design_air.shtml

2.3.2 Emergency Generators:

- Before the purchase and installation of an emergency generator having an output capacity **equal to or greater than 37 Kw**, an engine certification that includes manufacturer's certificate of emission performance must be filed with DEP in accordance with 310 CMR 7.26(40)-(44).



- An exhaust stack shall be installed so as to not cause or contribute to a condition of air pollution back into the building of interest (e.g. stack height is 10 feet above rooftop, vertical discharge, avoiding discharge into nearby fresh air intakes or windows.)
- If the unit is to be placed outside a building, then it shall be installed with weather-protective enclosure with removable or hinged side panels to allow inspection and maintenance.
- At minimum, the unit shall be installed with a critical degree silencer to minimize noise pollution. Check with local noise ordinances and ensure compliance.
- At minimum, the installation shall include a fuel meter and elapsed-time indicator.

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.
- 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 cooling tower(s) that have the potential to emit **greater than one ton of particulate matter or 20,000 gpm of blowdown** requires DEP approval in accordance with 310 CMR 7.02(1).

2.4 Installation of Fuel Storage Tanks

2.4.1 Permitting

The Contractor must be properly licensed 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.



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Aboveground storage tanks and associated piping shall be properly installed and permitted in accordance with, but not limited to, 527 CMR 4.00 and 527 CMR 9.00. Underground storage tanks and associated piping shall be properly installed and permitted in accordance with, but not limited to, 527 CMR 4.00, 527 CMR 9.00, 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)).
- If the quantity of light or heavy fuel oil exceeds 10,000 gallons, ensure that an application for registration and license has been submitted to the Massachusetts Department of Public Safety, the local Fire Department, and the License Commission (527 CMR 4.03 (1)(e)).
- 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 aboveground and underground storage tanks, the minimum design criteria outlined in Sections 2.4.2 and 2.4.1 below must be met.

2.4.2 Aboveground Storage Tanks

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 overflow, 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.

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.

Above ground storage tanks that are made of less corrosive material such as polyethylene should be considered.

2.4.3 Underground Storage Tanks

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 manufacturers 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 U.S. Environmental Protection Agency Standard Test Procedures for Evaluating Leak Detection Methods (EPA/530/UST-90/004 through 010) or other equivalent test procedures.

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 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.

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 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 the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*.

Storage: In every flammable storage room, an aisle of at least 3 ft 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 NFPA 30, Flammable and Combustible Liquids Code 2003 Edition, section 6.3. These meet the requirements of 527 CMR 14.03 (18) d. Any liquid storage cabinet meeting one of the following criteria is acceptable.

Any listed storage cabinet that has been designed and constructed to limit the internal temperature during fire testing as specified in NFPA 30-2003, section 6.3.3 (1).

Any metal storage cabinets that is constructed in the following manner:

- The bottom, top, door, and sides of the cabinet are double-walled with 38 mm (1½ in.) 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 in.) above the bottom of the cabinet to retain spilled liquid within the cabinet.

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 in.) thick and of a type that will not break down or delaminate under fire conditions.
- All joints are rabbetted and fastened in two directions with wood screws. Where more than one door is used, there shall be a rabbetted overlap of not less than 25 mm (1 in.).
- 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 in.) depth of liquid is provided at the bottom of the cabinet to retain spilled liquid within the cabinet.

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.



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 Laser Safety Officer (LSO) in the Department of Environmental Health and Safety. Further contact information for the LSO can be found online at:

<http://www.uos.harvard.edu/ehs/rad.shtml>

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 below.

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 below). 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 log 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:
 - a. *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.
 - b. *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.
 - c. *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 areas of a project that should consider future 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 avoid pest problems after occupancy of a building:

- Entrance ways shall be designed to prevent birds from perching directly overhead.
- Entry ways, including exit doors, electrical cables, exhausts, piping, plumbing and other penetrations through the building 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 small bushes that attract litter and becomes cover for burrowing rodents.



- Consider placing a perimeter of crushed stone around the outside of the building to keep pests from concentrating at building thresholds.
- Planting of trees close to a building will increase the probability of squirrels and raccoons crawling on the roof and eventually trying to find a way inside.
- Landscaping used to hide dumpsters from view may also serve as cover for rodent activity.
- Install proper drainage to prevent standing water on grounds. This will reduce mosquito breeding habitats.

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 in. (50-69 cm). 28.5 in. (72 cm) for a nonadjustable work surface at the front edge. An adjustable work surface should have an adjustable range between 19.5-28 in. (50-72 cm). Clearance for knee height is 19.6-25 in. (50-65 cm) at 17 in. (44 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 in. (122 cm), with 96 in. (244 cm) being more desirable. Sitting wells (space under the desk) should be at least 32 in. (81 cm) wide under the work surface. If possible, the sitting well should also be 39 in. (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 in. (76 cm) deep and come in a variety of widths. For writing tasks, an area of 12 in. (30 cm) wide and 16 in. (41 cm) deep, preferably 30 in. (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 in. or 3 mm) and have a nonreflective 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" (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" high. Work surface depth and width should be 30" Knee depth should be 15". 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 table below for chair criteria:

| Guidelines | Area |
|--|---|
| Seat pan height-adjustable | 16"-21" (40-52.5cm) |
| Seat pan depth-adjustable | 15-17" (32.5-42.5 cm) with waterfall sloping front edge |
| Seat pan with adjustable | 18"-22" (45-55cm) |
| Seat back tilt minimum range | 0°-15° |
| Seat back height minimum | 14" (35 cm), width min .12" (30cm) |
| Lumbar support location in lumbar region of the back | Lumbar support depth 1.2"-2" (3-5cm) |
| Five-legged stability | n/a |

3.0 SPECIFIC FACILITY DESIGN CONSIDERATIONS

3.1 Food Service Establishment and Retail Food Establishment

3.1.1 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 EH&S Public Health Manager, 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, (ie: building, plumbing, electrical, gasfitting, etc.) When required, work to be performed must be done by licensed persons.



HARVARD UNIVERSITY

EH&S Guidelines for Design

- When required, a **Certificate of Occupancy** must be obtained in accordance with the Massachusetts State Building Code (MSBC), and the Cambridge Zoning Ordinance.
- When required, a **Certificate of Inspection** must be obtained in accordance with the Massachusetts State Building Code.
- 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 above-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 for additional information:

| | | |
|----|---|--|
| A) | Cambridge Zoning Ordinance | sold in Cambridge City Clerk's Office |
| B) | MSBC | sold in Massachusetts State House Book Store |
| C) | MA State Electrical Code | sold in Massachusetts State House Book Store |
| D) | MA State Plumbing/Gas Code | sold in Massachusetts State House Book Store |
| E) | MA Architectural Access Board | sold in Massachusetts State House Book Store |
| F) | State Sanitary Code for Food Service Establishments | sold in Massachusetts State House Book Store |

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 EH&S Public Health Manager, 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 2 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 pre-operation inspection will be scheduled. When the inspection has been satisfactorily completed, a Food Service Permit will be issued.

You may download a **City of Boston Food Service Permit Application**, or a **City of Boston Plan Review Application** @ www.cityofboston.gov/isd/forms.asp

In an effort to ensure that all relevant regulatory requirements are incorporated into the design documents for all project involving food service establishments, whether permitting is required in Cambridge or Boston, the following issues have been highlighted: (note that the Massachusetts State Sanitary Code, Chapter 10, Minimum Sanitation Standards for Food Establishments, is referred to throughout as the Food Code (FC)):

3.1.2 Coordination with Harvard EH&S Department

In addition to submitting all permit applications to the Project Manager and the EH&S Public Health Manager as noted above, other relevant design documents must also be provided so that the EH&S Public Health Manager 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 EH&S Public Health Manager's comments can be incorporated into the final design documents (the EH&S Public Health Manager 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 11x14 in size, accurately drawn to a scale of ¼ inch = 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.



3.1.3 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.

3.1.4 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.

3.1.5 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.

3.1.6 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.

3.1.7 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.

3.1.8 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.

3.1.9 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.

3.1.10 Equipment

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

3.1.11 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*.

3.1.12 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.

3.1.13 Minimum Lighting Requirements

The Massachusetts State Sanitary Code For Food Service Establishments, 105CMR 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:

| Minimum Footcandles (Lux) Required | 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. |



3.1.14 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.

3.1.15 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.

3.1.16 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).

3.1.17 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.

3.2 Laboratory Design

3.2.1 HVAC System

The HVAC system shall all meet requirements of Harvard University Design Considerations for HVAC Systems (Section 2.2). In addition, laboratory ventilation in all newly constructed buildings shall meet the requirement of ANSI/AIHA Z9.5-2003 *Laboratory Ventilation* unless otherwise specified.

The desired directional airflow between rooms shall be identified in the design and operating specifications. In general airflow should be from low hazard to higher hazard area except in special laboratory designs. Labs using hazardous materials that must be kept under positive pressure should have an anteroom, which is at negative pressure relative to corridors or other non-lab spaces.

3.2.2 General Ventilation

The specific design goal for the laboratory ventilation rate will depend upon factors such as: the hazardous properties of materials used; the quantities of chemicals stored and used; the type of processes performed within the lab; the design and placement of local exhaust ventilation such



as fume hoods and gas cabinets; the size of the laboratory; the design and placement of supply diffusers and return grates; and the heating and cooling loads of the laboratory. *The ASHRAE Handbook 2003 – Applications* states that 6 to 10 air changes per hour (ACH) provide adequate ventilation for most laboratories. In the absence of specific information regarding laboratory operations, 8-10 ACH should be used for HVAC design purposes. In some laboratories lower rates may be appropriate. These situations will be reviewed by an EH&S representative and recommendations will be made on a case-by-case basis. Ventilation rates higher than 10 ACH may be required for select areas such as animal holding areas or laboratories with large scale use of high hazard chemicals. Where appropriate, ventilation rates may be reduced during unoccupied periods, but should not be reduced below 4 ACH [*NFPA 45 Standard for Fire Protection for Laboratories using Chemicals A.8.2.2*] unless otherwise specified by EH&S.

3.2.3 Laboratory Fume Hoods

Laboratory fume hoods shall comply with the Scientific Equipment and Furniture Association's SEFA-1 Recommended Practices for Laboratory Fume Hoods in material, components, type and testing. Laboratory fume hood exhaust ventilation may be constant or variable air volume depending on user and facility management considerations of function, initial cost, and life cycle cost issues. Auxiliary air chemical fume hoods are not recommended.

Airfoils: An airfoil sill shall be provided at the front edge of work bench. The airfoil sill shall have a bypass between airfoil and bench to allow airflow when sash is closed. Bypass design should allow for passage of electrical cords, hoses, etc. into the interior of the hood. Airfoils shall also be provided at the front of side posts external to the sash.

Hood Interior: All internal surfaces of fume hood chamber and baffles shall be constructed of materials that are resistant to the chemical fumes, vapors and precipitates that may collect on those surfaces. Liner materials shall be flame retardant, self extinguishing and have a flame spread rating of 25 or less in accordance with ASTM-E84. Fume hood chambers with high fire risk may require fire suppression and alarm systems.

Hood Monitor: All hoods shall have a visual indication of face velocity and/or exhaust flow ventilation. Monitoring device should provide clear indication to the hood user whether or not exhaust flow or face velocity is within design parameters. A local audio and visual alarm indicator within the laboratory where the alarm set point is 80 percent of design velocity

Sash: Laboratory fume hoods shall be equipped with a vertical, horizontal or combination type sash, that moves freely and does not bind. All sashes shall be equipped with shatterproof safety glass. Sash stops shall be installed at 18 inches on all vertical sashes.

Open Bypass: All constant air volume hoods with vertical sashes shall be equipped with an open by-pass designed such that face velocity when the sash is at six inches shall not exceed 3 times the face velocity when the sash is in the wide open position.

Restricted Bypass: All laboratory fume hoods installed in VAV systems or equipped with horizontal or combination sashes shall be provided with a restricted bypass. Hood exhaust volume shall not be reduced below 25 cfm/ft of hood width or 25 cfm/ft² of work area, whichever is greater.



Work Surfaces: Work surfaces should be recessed at least 3/8 inch below the front edge of bench or surface. Sides and back should be provided with seamless vertical lip at least 3/8 inch high.

Hood Lights: Access for light changes should be from exterior of the fume hood. Lights shall be separated from interior by vapor tight tempered glass panel. Light should provide a minimum of 80 foot-candles on any part of the bench level.

Hood Services: Service fixtures shall be installed so service supply lines can be connected or disconnected by design of piping assembly or an access panel in the hood interior or exterior.. All service valves shall be accessible for maintenance. All service controls should be external to hood interior, clearly identified and within easy reach. All internal service fixtures shall be corrosion resistant to the application.

Electrical Services: All electrical services should be readily accessible and external to the hood interior. All electrical wiring shall be isolated and physically separated from vapors handled within the hood interior. The receptacle shall be installed with the ground outlet above the power slots.

Fire Suppression: Any fire suppression system installed shall meet local code requirements and NFPA 17. Fire suppression system should be rated for Class A, B and C fires.

Fire Dampers: No fire dampers of any kind shall ever be installed in a laboratory fume hood exhaust system.

Fume Hood Location: Laboratory fume hoods shall be located so their performance is not adversely affected by cross drafts. Avoid installing hoods near doors, supply air diffusers, operable windows, heavy traffic areas or other exhaust ventilation devices. Sufficient aisle space should be provided in front of the fume hood to avoid disruption of work or interference with hood user by passing personnel. Laboratory fume hoods should be located so as to allow safe egress from the laboratory in the event of spills or fire within the hood.

Fume Hood Performance: Chemical fume hoods will operate continuously and must achieve a face velocity of 100 fpm at an 18-inch height position for vertical and combination sashes with a uniform face velocity profile of +/-20% of the average velocity. Supply and exhaust systems shall be balanced so as to provide adequate makeup air for local exhaust devices, provide adequate ventilation and air exchange, maintain appropriate pressurization and provide appropriate heating or cooling as needed.

3.2.4 Special Hoods

Perchloric Acid Hoods: Any laboratories that will use heated perchloric acid shall be equipped with a perchloric acid hood. In addition to general design requirements for laboratory fume hoods perchloric acid hoods shall meet additional design requirements as specified in section 8.11 of NFPA 45 -2004 Standard for Fire Protection for Laboratories Using Chemicals and section 3.2.4 of ANSI/AIHA Z9.5-2003. Additional requirements include, but are not limited to the following.

Perchloric acid hood interiors shall be constructed using materials that will not corrode or react with perchloric acid or form corrosive, flammable, and/or explosive compounds or by-products. Non reactive and corrosion resistant material should extend all the way through the exhaust system. Exhaust ducting shall be constructed of perchloric acid resistant materials that will not react with perchloric acid or any of its by-products. All duct joints shall have smooth welded



seems. Fan blades shall be corrosion-resistant and non-reactive. The exhaust fan motor shall not be installed in the ductwork and the pulley shall be conductive as specified by NFPA 45.

Perchloric acid hoods shall be equipped with a built-in water wash-down system that will adequately spray all interior surfaces of the ducting, tack, fan, plenum, baffles, and hood. Perchloric acid hoods shall be provided with a 0.5 inch deep liquid-tight hood. An integral trough should be placed at the back to collect wash water runoff and shall be provided for new perchloric acid hoods. Drain outlets shall be designed to handle a minimum of 15 gallons per minute. The fume hood interior liner shall have no access holes or panels. Design shall allow for easiest possible visual inspection, including removable baffles.

Perchloric acid hoods shall not be manifolded or connected to any non-perchloric acid exhaust system.

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.

Ductless Hoods: Ductless fume hoods are not recommended for laboratory use involving hazardous materials. A Hazard Evaluation and Analysis of the work to be conducted in such hoods shall be conducted by Harvard EH&S or consultant prior to purchase or installation. Ductless hoods shall only be used for operations that could normally be performed on the bench without presenting an exposure hazard.

Ductless hoods shall be posted regarding allowable chemicals, types and limitations of filter types and change out schedule, and that the hood re-circulates air to the room.

3.2.5 Gas Cabinets

The Massachusetts Building Code 6th Edition [Table 307.8(2)] requires that any amount of a highly toxic gas be used or stored in approved exhausted gas cabinet, exhausted enclosure or fume hood. *NFPA 45 Standard for Fire Protection for Laboratories Using Chemicals* [11.1.4 Special Ventilation Requirements for Gas Cylinders] requires the use of a continuously mechanically ventilated hood or other continuously mechanically ventilated enclosure for any gas with an NFPA Health rating of 3 or 4 or any pyrophoric gas. Any laboratory using or storing any amount of a gas with any of the following NFPA hazard ratings should be reviewed by EH&S to determine the need for specialized local exhaust ventilation: Health 3 or 4, Flammability 4, meeting any of the following criteria may need to be equipped with gas cabinets or ventilated enclosures. EH&S will also determine the need for gas detectors, alarms, and flow control and purge equipment. Laboratory gas equipment or apparatus that releases these or other highly toxic materials may also require a ventilated enclosure if they cannot be vented directly to a tall stack or when leakage into occupied areas is likely. The design of ventilated enclosure other than gas cabinets or laboratory fume hoods should be reviewed by EH&S on a case by case basis.

Any gas cabinet or vented enclosure housing such gases shall be connected to a mechanical exhaust system.

Gas cabinets shall be constructed of 12-gauge steel or thicker. Cabinet shall be equipped with a self-closing and self-latching door, and a self-closing window that allows access to controls.



Operational louvers shall be present to allow for adequate ventilation even when the door and window are closed.

Gas cabinet interiors shall be treated, coated, or constructed of materials that are compatible with the material stored.

Gas cabinet should be equipped with a manual cylinder shutoff valve or valve-wrench fitting that is easily accessible. The valve handle can be located outside the enclosure or cabinet. Controls within a cabinet shall be visible and easily readable, and located in a place where the controls can be easily read. Routine operating controls or displays should be posted on the outside of a gas-storage cabinet whenever possible.

Gas cabinet exhaust flow shall produce an average face velocity through the cabinet window of 200 fpm or greater and the minimum face velocity 150 fpm at any point. Test smoke released anywhere in the plane of the window or door shall never flow outward.

Gas cabinets shall be provided with listed or approved automatic sprinklers whenever pyrophoric gases greater than lecture bottle size are in use. Automatic sprinklers shall be the corrosion-resistant type and installed in accordance with NFPA Standard 13, "Standard for the Installation of Automatic Sprinkler Systems." Listed or approved automatic sprinklers may be indicated for flammable gas storage in some cases depending upon location and quantities.

3.2.6 Exhaust Fans

Laboratory exhaust fans shall be located outside building, preferably on the highest level roof or in a rooftop penthouse or mechanical space designed for such use.

Fans shall be sized so as to meet exhaust volumes, stack exit velocity and pressurization under all expected operating conditions.

Fans shall be positioned so as to allow ready access to all fans, motors, belts, drives, isolation dampers controls and attached duct work. Fans shall have adequate space for removal and replacement of fan and/or fan parts.

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 fume hood 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 stacks should be at least 10 feet above adjacent roof lines and air intakes. Exhaust shall be directed upward with a minimum discharge velocity of 3000 fpm.

Any architectural barrier constructed to mask unwanted appearance of stacks, penthouse, mechanical equipment shall be evaluated for its effects on re-entrainment. Air intakes and or exhaust grills shall not be located within such barriers unless demonstrated to be acceptable.

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.



3.2.7 Ducts

Laboratory exhaust duct work shall comply with appropriate sections of Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) latest edition of standards, ANSI/AIHA Z9.2 *Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems*, Chapter 35 on Duct Design in the ASHRAE 2005 Handbook – *Fundamentals*, and 6-5 of NFPA 45 -2004 *Standard for Fire Protection for Laboratories*;

3.2.8 Gas Detection and Alarms

A hazardous gas shall be considered any compressed or liquefied gas with an NFPA 704 rating of Health 3 or 4, Flammability 4, or Instability 3 or 4; and carbon monoxide in cylinders greater than lecture bottle size (0.4 L). The design of any laboratory intending to use or store hazardous gas or gases should be reviewed by EH&S to determine if detection, alarm and control systems should be incorporated into the laboratory design. The following information will be reviewed on a case-by-case basis to determine what systems are indicated for a particular application.

- The hazardous properties of the gas
- The physiological warning properties of the gas
- The amounts and concentration of the gas in use
- The process parameters of the experimental application

Detection, alarm and control systems will be required more commonly for continuous operations and long-term research situations where personnel may be exposed to concentrations approaching the OSHA Permissible Exposure Limit (PEL) or ACGIH Threshold Limit Value (TLV).

Hazardous gas detection systems, where required, should be equipped with audible and visual alarms. Hazardous gas monitors and alarms should also have an uninterruptible source of power. Toxic gas (NFPA Health 3 or 4) detectors monitoring the ambient laboratory air should be capable of detecting concentrations at or below ½ of the PEL or TLV. Toxic gas alarm levels may be higher for detectors placed inside exhausted enclosures. Alarm levels for flammable gas detectors may be set at higher levels depending on the lower explosive limit and toxicity of the gas. Local hazardous gas alarms should be placed in the laboratory near the potential release point, and in some cases at select locations immediately outside the laboratory. In applications assessed to be high risk by EH&S, alarms may also require remote, supervised critical alarm points in addition to local alarms. These high risk uses of hazardous gases may also require alarms to release “fail-safe” actuators to shut off the gas at the source. Emergency response protocols should be considered during design phase of detection and alarm systems, with the input of facilities personnel, if possible.

Ventilation requirements for hazardous gases can be found in the Laboratory Ventilation sections of this document (Sections 3.2.1 – 3.2-7). A partial list of hazardous gases that would require an EH&S review is given below.

| | | |
|---------------------|-------------------------|-----------------------|
| ammonia | germane | nitric oxide |
| arsine | germanium tetrafluoride | nitrogen dioxide |
| boron trifluoride | hydrogen | nitrogen trifluoride |
| bromine | hydrogen bromide | nitrous oxide |
| carbon monoxide | hydrogen chloride | phosphine |
| carbon tetrabromide | hydrogen fluoride | silane |
| chlorine | hydrogen selenide | silicon tetrachloride |



| | | |
|----------------|------------------|-----------------------|
| diborane | hydrogen sulfide | silicon tetrafluoride |
| dichlorosilane | methyl chloride | sulfur dioxide |
| disilane | methyl fluoride | trichlorosilane |
| fluorine | | |

3.2.9 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 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 | Exhaust is typically discharged to the outside. Exhaust is High Efficiency Particulate Air (HEPA) filtered if air is recirculated into the room. Suitable for manipulation of low to moderate risk agents. |
| Class II, Type A1 | Yes | Yes | Exhaust is recirculated into the room or discharged to the outside. Have positive air pressure plenums. More suitable for manipulation of low risk agents and sterile materials. |
| Class II, Type A2 | Yes | Yes | Exhaust is recirculated into the room or discharged to the outside. Plenums under negative air pressure. Suitable for manipulation of low to moderate agents and sterile materials. May be used for small amounts of volatile toxic chemicals and trace amount of radionuclides if exhausted to the outside. |
| Class II, Type B1 | Yes | Yes | Externally ducted exhaust. Plenums under negative air pressure. Suitable for manipulation of low to moderate materials. May be used for low levels of volatile toxic chemicals and trace amounts radionuclides. |
| Class II, Type B2 | Yes | Yes | Externally ducted exhaust. Plenums under negative air pressure. Suitable for manipulation of low to moderate risk agents. 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, and
 - Install away from operable and unlocked windows,
 - Ensure that the room has mechanical exhaust ventilation in addition to exhaust ventilation provided by the 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.

Certification of Biosafety Cabinets

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

3.2.10 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 above 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 routing cleaning and decontamination of storage facility.

3.2.11 Hazardous Waste Main Accumulation Areas

Compliance/technical requirements for Hazardous Waste Main Accumulation Areas (MAA) are prescribed in Massachusetts Department of Environmental Protection's regulation - *310 CMR 30.340*. The following considerations should be made when designing a hazardous waste storage area:

- The hazardous waste storage area should be located in a room or area away from public access and equipped with appropriate security to minimize public access. Doors to the area must be properly fire-rated and equipped with locks to prevent unauthorized entry.
- Size of the storage area should include considerations of the number of laboratories, type and amount of waste each laboratory generates.
- Area must be set-up to ensure that waste containers can be adequately segregated and contained. In addition, there must be enough space to ensure at least 3 feet of aisle space between shelving and/or waste containers.
- Area must be equipped with a dedicated ventilation exhaust system designed to adequately control volatile emissions in area. The ventilation rate should be 1 cubic feet per minute per square foot (cfm/ft²) or a minimum of 150 CFM and the system should be ducted directly to the outside away from windows, doors, fresh air intakes.
- The floor must be sealed (typically an epoxy-resin to eliminate all cracks and gaps and a berm installed at doorways or other locations where spilled material could escape the room). The containment system (floor) 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, whichever is greater. All floor drains in the room must be sealed & plugged.
- The area should be large enough to store waste containers, as well as, emergency response equipment and a hazardous waste cart used to transport waste from laboratories and operational areas to the storage area. Typical dimensions of a waste cart are 32 inches high, 40 inches long and 25 1/2 inches wide.
- Area shall be equipped with the following equipment:
 - Telephone - able to call an outside emergency agency (e.g. fire dept.),
 - Fire Suppression System and fire extinguishers - appropriate for the fire hazard presented by the wastes stored in the area,
 - Fire alarm and detection equipment - a horn and strobe device should be located in the room, a pull station should be located along the egress pathway close to the room, and appropriate detection devices installed in the room,
 - Intrinsically-safe lighting,
 - Emergency shower and eyewash,
 - Spill kit must be located in area and there must be access to emergency shower and eye wash,
 - Shelving- stable, heavy duty metal shelving equipped with containment lips/edges to prevent spillage,
 - Emergency Egress Map- required by the Hazardous Waste Contingency Plan, and
 - Exit Signs - posted at all exit ways from the area.



3.2.12 Laboratory Wastewater Systems

General Discharge Issues

- Non-contact cooling water discharge is prohibited from discharge to the Massachusetts Water Resource Authority (MWRA) sewer system. The installation of compressors, autoclaves, cage washers and other equipment shall be designed to not discharge water to waste. This discharge should be recycled and reused in the facility.
- Reverse osmosis (RO) reject water is prohibited from discharge to sanitary sewers where separate storm sewer systems exist. The RO reject water must be reused or an Environmental Protection Agency/Department of Environmental Protection (EPA/DEP) RO Reject General National Pollutant Discharge Elimination System (NPDES) Permit is required.
- Photo processors and darkrooms containing X-ray units and other equipment using silver in a fixative or developer must have silver recovery systems installed or this material must be collected as hazardous waste.
- Under the sink chip tanks are not recommended. Local City Plumbing inspectors are discouraging the use of chip tanks to treat laboratory wastewater. See below for alternate designs.

pH Neutralization Systems

- Configuration - Whenever possible, a two-tank system is preferred over a single tank system. A two-stage system allows for a greater retention time and more opportunity to control pH. The system configuration can be continuous flow, batch, or modified depending upon whether wastewater is pumped to the system and if wastewater is pumped up to grade level. Systems should not be installed in areas defined by OSHA as confined spaces.
- Neutralization Tanks - Cylindrical configurations are easier to clean and maintain in comparison to rectangular tanks. Tanks should be easy to service. If tanks are tall, a suitable platform should be installed to allow safe access to the top of the tanks. Tanks should be sealed and vented sufficiently so that odor does not become a problem. The room containing the neutralization system should be adequately ventilated to minimize odors.
- Tank System Piping - When possible, design piping to isolate one tank for cleaning and allow the alternate tank to maintain in full operation. This will allow cleaning of tanks to take place during normal hours of operation.
- Inlet Settling Tank – A small tank with baffling, basket strainer, cleaning ports and compartment drains is recommended to isolate debris from entering the larger tanks. A diagnostic inlet pH meter and sampling ports should be installed in this settling tank to inform building facility management of laboratory activity.
- Reagent Stations – An enclosed fiberglass unit with clear view doors equipped with secondary splash containment is preferred. Each reagent should be segregated and low-level sensors installed. It is recommended that polypropylene containment for acid and caustic pumps and barrels be used.
- Chemical Feed Lines – Feed lines must be encased in a chemical-resistant containment sleeve. The interface connection of feed lines at the pump and inlet tank should be installed with a PVC containment device to capture small spills.
- Auxiliary Equipment Standardization– In an effort to maintain operational standardization, the following auxiliary pieces of equipment should be compatible or similar to those used on existing pH systems: chemical metering pumps, pH controllers, pH probes,



transmitters, tank mixers, and data recorders. Some of the suggested manufacturers of this equipment include Foxboro, GLI and Honeywell. A review should be made of existing pH systems nearby to ascertain compatible/similar devices. Additional issues to address include the following:

- pH controllers - Bi-directional, proportional or Proportional Integral Derivative (PID) control
 - pH probes – Sensor mounting assembly, top entry preferred. Self-cleaning probes preferred.
 - Transmitters – 24v DC preferred
 - Tank Mixers – Utilize a positive gasket or mechanical seal to minimize odor leaks into the working space.
 - Recorder – Shall be a circular chart recorder, single (preferred) or multi-pen, pen cartridge, not thermal with a data logger, with communications and trending and a local display.
- Sampling Port - Place sample port in location that maximizes sampling of characteristic discharge and minimizes collection of accumulated debris. Do not install at the base of a U-trap on discharge pipe, rather install it along the side of the pipe. Install MWRA sampling port with 3/8" valve. Clean-outs may be warranted.
 - Flow Meter – Flow meters must be capable of providing variable flow rate, as well as total and composite flow rates.
 - Alarms Interface – System alarm system should be able to send multiple alarm signals (i.e. General trouble, power loss, critical and non-critical alarms, etc.)
 - Eye Wash/Safety Showers – System area must be equipped with an (or accessible) emergency eye wash station and emergency shower. Consideration must be given to ensure System Operators have ready access to egress routes and emergency lighting.
 - Labeling – System devices and pipes should be clearly marked and labeled to identify function and any potential hazards.

3.2.13 Lab Pest Control

- Labs engaged in biological or nanotechnology research including animal/plant transgenic, BL3 or higher, clean room research and infectious disease research should be designed to eliminate insect 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 BL3 or other animal facility requires an insect tight construction, then contact the Pest Control Office at EH&S for a detailed review and assessment.
- Minimize the number of floor drains in a facility.
- Specify animal cages that contain sealed tubing so that insect 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.



Architect/Designer Acknowledgement

I, (print name) _____, a (print title) _____,
at (print firm) _____, confirm that I have read and understand the issues outlined
in this document. 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
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Date: _____