Yale University

Guidelines for Safe Laboratory Design

Prepared by Yale University

Environmental Health & Safety

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Contents

1. Introduction

This document provides basic EHS guidance to follow when designing for laboratory spaces at Yale University. The guidance contained in this document is intended to be a supplement, as all laboratories must be designed to comply with all applicable codes, including NFPA, New Haven and State of CT building codes.

This document may not address all the needs and requirements of some highly specific, unique, and/or high hazard laboratories. EHS must be included early on in all laboratory design projects. It is important to review laboratory design with the proposed occupants as early in the process as possible, to ensure compatibility with anticipated research or teaching activities. These guidelines are not meant to be used in lieu of regulatory and code reviews.

2. Laboratory Design

General Design

a. Area Layout

- Provide adequate amount of separate break area(s) close to the laboratory area, with separate dedicated food refrigerators to discourage eating and drinking in labs.
- Avoid locating desks and study carrels within laboratory. If not possible, include splash protection/separation from wet bench areas to reduce PPE requirements.
- Design doors, hallways, and aisles of sufficient width for standard lab carts and equipment moves.
- Provide dedicated storage areas, closets, and/or hanging areas for lab coats and for personal items and clothing. Lab coat hangers should be located near the entrance to the lab.

b. Ergonomics and Materials Handling

- Sufficient workspace must be provided for individual workers to perform anticipated tasks. Space requirements should be based on the number of people, the equipment, equipment clearances required for maintenance, setup and operation, materials storage locations relative to personnel and anticipated growth/changes over time.
- The design phase and equipment selection should include ergonomic considerations to reduce high risk lifting tasks, awkward posture, extended reaches, and handling distances.
- Equipment adjustability should be considered to allow for multiple personnel to improve productivity and comfort.
- Provide appropriate lighting for workspaces and tasks. Avoid fixture types and placement, which creates glare and/or shadows.
- Load ratings should be conspicuously posted on plates, raised platforms, and other engineered elevated structures or projections.
- Contact EHS for additional information and for designs involving significant materials handling and repetitive operations.
- Contact EHS for loading dock, powered industrial truck, crane and hoist requirements.

c. Maintainability

- Design for adequate clearances, accessibility, and lighting for maintenance personnel.

- Install labeled energy isolating devices and equipment in accessible locations.
- Eliminate confined spaces where practical.
- Provide passive fall protection (i.e. rails) for all four feet and greater fall hazards where routine maintenance is required (including rooftop mounted equipment).

Infrastructure

a. Lab and Hall Doors

- Provide glass panels or viewing ports to facilitate interior observation.
- Provide laboratory entry doors and inner lab doors with self-closing door mechanism.
- Use fusible links or a magnetic catch system interconnected with fire/smoke alarm systems, if doors must be kept open between laboratories.
- Hallway doors should be installed on infrared or other automatic opening door systems to facilitate movement of materials and carts along halls.

b. Entry Signage/Safety Stations

- Provide standard 8.5 x 11-inch clear plastic sign holders outside door, to accommodate lab door sign (required per NHFD agreements), including all inner rooms and support rooms.
- Provide a safety station area near the main laboratory door for the phone, fire extinguisher, safety postings, and holders for visitor safety glasses.

c. Exits

- Do not use radioactive self-luminescent exit signs.
- Design so that there are direct and unobstructed paths to exits from all areas of the laboratory.
- Provide more than one exit from the laboratory as required.

d. Walls and Ceilings

- Surfaces should be smooth and easily cleanable.
- No ACM/friable ceiling tile styles.
- Recessed lighting preferable over suspended styles, but avoid placement directly above lab benches.
- Incorporate energy efficient lighting designs whenever possible.
- Windows should generally be non-openable to avoid defeating HVAC, fume hood, and biological safety cabinet systems.

e. Shelving

- Wall and above-bench shelving to maximize accessible storage space.
- Chemical resistant finish surfaces.
- Shelf lips are recommended to reduce accidental slides/pushes of bottles off shelves. Alternatively, a center shelf partition on back-to-back lab bench shelving systems can be used.
- Height/placement should not require the use of portable ladders and steps for frequently accessed shelves.
- Locate shelving so that stored materials can maintain 18” distance from ceiling to allow for fire sprinkler clearance.

f. Benches and Worksurfaces

- Chemical resistant and durable finish surfaces.
- Appropriately rated to support equipment and stored items.

g. Hallways (Corridors)

- Sufficient width and height to accommodate pedestrian, cart, and equipment traffic.
- Avoid door/threshold saddles and carefully evaluate expansion joint designs to prevent pedestrian and lab cart accidents.

h. Flooring

- Ensure new flooring materials are non-asbestos.
- Carpeting prohibited in lab, lab support, clinical, and related work areas.
- Easily washed, non-porous, coved, spill/leak resistant (i.e., seamless sheeting preferred over vinyl tile).
- Caulk/seal all floor penetrations to retard migration in the event of spill or flood.
- Walking and working surfaces should be designed to provide personnel with a stable, firm, and slip resistant environment. Surfaces likely to be wet should have a Dynamic Coefficient of Friction of 0.42 or greater (i.e. high traction surface).
- When applicable, ensure appropriate slip resistance design specifications are attained upon installation.
- Where wet processes are used, drainage must be maintained and gratings, mats, or raised platforms provided.

3. Plumbing

General

- Back-flow prevention (anti-siphon) devices required on all sink installations and fixed water consuming equipment.
- Wastewater neutralization systems are not recommended and must be approved by EHS.
- Where house natural gas is needed, design and install so that each lab can be shut-off by valving located just outside lab. Use clear glass/plastic cover and label shut-off location prominently.
- Deionized water plans should be discussed with user prior to design and may require registration with EHS for wastewater discharge permitting.
- City water may not be used for equipment or space cooling. Instead, use chilled water or install point-of-use recirculating chiller.
- Isolation valves for servicing, maintenance and emergencies must be accessible and labeled.
- Handwashing sinks are required in all laboratories.

Emergency Eyewashes and Showers

- Provide emergency eyewash and shower safety devices per ANSI Z358.1 requirements
    - Tepid water
    - Within approximately 55 ft unobstructed travel distance
    - Capable of activation in a single motion within 1 second and remain on once activated in a hands-free operation mode

    - Eyewashes must be capable of flushing to both eyes simultaneously
- Water source for emergency water devices must be potable.
- Eyewashes must be located in every wet lab, including tissue culture facilities.
- Eyewashes may be sink-mounted, stand-alone, or combined with a shower as a separate emergency water station.
- Eyewashes must be plumbed directly to a drain or located at a sink to promote regular testing.
- Emergency showers must be located inside laboratories where corrosives are handled. Additional emergency showers should be placed in corridors.
- A private, emergency shower should be located in nearby restrooms on each floor whenever feasible.
- Each shower installation must have a secondary shut-off (ball) valve just upstream from unit. It should be located out-of-view where possible and installed with a lock-out mechanism. Shut-off valve must be in "open" position at time of lab commissioning.
- Floor drains for safety showers are allowed, but not required by EHS. Consult Facilities Operations for advice.
- Emergency eyewash and shower stations must be posted with large, high visibility signs.

4. Electrical

- Maximize number of separate circuits to avoid overloads.
- Power disconnects, switches, and circuit panels must be clearly marked, circuits labeled, and centrally located for prompt access by qualified personnel.
- Adequate and appropriate grounded outlets on multiple circuits to minimize needs for power outlet strips and extension cords. The anticipated equipment, operations, and growth should be accounted for.
- Label outlet/switch receptacles to identify circuit source.
- 220V power available, and supplied as needed especially in equipment rooms.
- When feasible provide emergency/back-up power for critical equipment and operations.
- Equipment installed must be listed or labeled by a nationally-recognized testing laboratory (such as Underwriters Laboratories, Inc. (UL)). All equipment must be designed and constructed to protect personnel.
- Ensure all electrical devices are properly grounded with approved three wire plugs unless they are “double insulated”.
- Use a suitable mechanical-strain-relief device such as a cord grip, cable clamp, or plug for any wire or cable penetrating an enclosure where external movement or force can exert stress on the internal connection.
- Guard circuits greater than 50 volts either through screw-on panels or through items such as interlocked doors, panels, or covers.
- Ensures safe access for personnel who inspect, adjust, maintain, or modify energized equipment. Clearances must be in accordance with OSHA, NEC, and the National Electrical Safety Code (NESC). Clearance space must not be used for storage or occupied by bookcases, desks, workbenches, or other items.

- Ground Fault Circuit Interrupter (GFCI) protection is required for receptacles outdoors, indoor wet locations (locations subject to saturation with water or other liquids) and within 6 feet of a water source. Receptacles installed in damp locations must have an enclosure for the receptacle that is weatherproof when the receptacle is covered (attachment plug cap not inserted and receptacle covers closed). The covers need to be listed weather-resistant (WR) type.
- New installations should include arc flash analysis and labeling per NFPA70E.
- Emergency generator installations must be registered with EHS for air discharge permitting with the State of CT DEEP.

5. Biosafety Cabinets (BSC)

- Provide vacuum and electric service to units. Use flexible connections where possible to permit limited re-positioning of BSC.
- Natural gas service discouraged but permitted at specific request of user.
- Thimble or hard-ducted exhaust connections may be warranted depending upon nature and hazard of materials used. Contact EHS for approval.
- All BSCs must be added to EHS-managed service/certification contract. All contracts with BSC service agreements shall be arranged by EHS.
- Biosafety cabinets must be NSF-listed.
- Purchases must be approved by EHS.

Biosafety Cabinet Location and Installation (information from NSF/ANSI 49 – 2019)

- Location:
    - Away from traffic patterns, doors, fans, ventilation registers, fume hoods, and any other air-handling device that could disrupt its airflow.
    - Locate on wall furthest from and facing the entry door. If not possible, locate on the side wall perpendicular to the hinge side of the door.
- Clearance requirements:
    - 12 inches from the exhaust filter face to any overhead obstructions to allow for exhaust filter testing. Required if exhaust filter testing is done with a thermal anemometer.
    - 6 inches from adjacent walls or columns.
    - 6 inches between two biosafety cabinets.
    - 6 inches between both sides of the biosafety cabinet and behind the BSC to allow for service operations.
    - 40 inches of open space in front of the BSC.
    - 60 inches from opposing walls, bench tops, and areas of occasional traffic.
    - 20 inches between BSC and bench tops along perpendicular wall.
    - 100 inches between two BSCs facing each other.
    - 60 inches from behind a doorway.
    - 40 inches from an adjacent doorway swig side.
    - 6 inches from doorway hinge side.

- Electrical requirements
    - The electrical outlet for the BSC should have a dedicated circuit breaker to prevent accidental shutdown of the unit if another piece of equipment overloads the circuit.
    - Some larger BSCs will require a circuit rated for 20 amp service. Some plugs and sockets for 15 and 20 amp ratings are not standard configuration. Confirm plug configuration with manufacturer
    - Note: Some cabinets do not operate properly when connected to a GFCI. If a GFCI outlet is present, consult with the BSC manufacturer about compatibility of their unit with a GFCI outlet.

6. Laboratory General Ventilation Design

- Locate supply air intakes distant from potential sources of contamination, including fume hood stacks, vehicle emissions, and exhaust from portable gas powered tools.
- Labs must be on 100% exhaust systems (no recirculation/re-use of lab exhaust).
- Design and balance systems so that lab rooms are slightly negative with respect to corridors and surrounding rooms.
- Design target is 8-10 room air changes per hour for occupied rooms, and 4-6 per hour for unoccupied rooms. All designs with air changes rates <8 must be approved by EHS.
- Laboratories which have air change rates <8, with EHS approval, must have an emergency purge button installed.
- Air change rate occupancy setbacks for energy savings are allowed based on a combination time-of-day and occupancy sensors.
- Design roof exhaust ejectors to good engineering practices, either 1.5 x building height or effective equivalent by high velocity release for good atmospheric mixing and dispersion (3000fpm unless demonstrated that alternate discharge velocity can meet dilution criteria).
- Provide redundant fans and means to ensure system maintains negative pressure during failures.
- Laboratory exhaust ducts in laboratory work areas (i.e., mechanical rooms) shall be kept at negative pressure by installing fans outside of buildings, preferably on the highest level roof or in a rooftop penthouse or mechanical space designed for such use.

Enthalpy Wheels

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

Demand Control Ventilation

EHS does not recommend the use of demand-controlled ventilation systems in laboratory work areas for the following reasons:

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

7. Local Laboratory Exhaust Ventilation

Chemical Fume Hoods

- For standard fume hoods, design to provide 100 feet per minute (fpm) linear air velocity into hood face (acceptable working range = 80 - 120 fpm, with sash height of 18" – not full open). Non-occupancy setpoints to 80fpm if applicable.
- For hoods rated by the manufacturer to run at lower face velocities, such as high performance fume hoods, design to 80 fpm +/- 20%. Non-occupancy setpoints to 60fpm if applicable. All hoods that are designed to operate at <100fpm face velocity must be approved by EHS.
- ASHRAE 110 testing required for all new fume hood system installations as part of commissioning.
- Hoods must have permanently installed visual flow indicators and alarms for off-normal conditions.
- Fume hoods should be appropriate for the control system being used. By-pass sash design required for constant air volume (CAV) systems, and hoods that are designed for variable air volume (VAV) systems should be selected when VAV systems drive the hood ventilation.
- Sash style should be either vertical or horizontal for constant volume systems, but can be combination vertical/horizontal operating sash with variable volume systems only. For horizontal sliding sashes, 12” panels are preferred to enable users to work behind it by wrapping their arms around the panel.
- Hoods should have chemically-resistant surfaces and finishes
- Locate hoods distant (i.e., $\geq$ 6 ft) from doors, pedestrian traffic ways, and overhead supply air diffusers to minimize deleterious effects of turbulence; front-to-front placement within the same room should be avoided.
- Most hood installations will require water, electric, and drain connections. Where required by user, also install gas service connection and house vacuum.
- Electrical outlets needed for equipment should be located on the hood exterior and must not be placed inside the hood.
- Lights must be easily accessible from outside of hood to facilitate timely replacement
- Code and label fume hoods with consistent, standardized system (e.g., building code-room number-hood number); fan, ejector, and ductwork also so labeled to facilitate common language during repairs and maintenance

- Hood cabinetry/casework should include flammable cabinets and possibly corrosive storage cabinets below, depending on chemicals used in the laboratory. Refer to the Chemical Storage information in Section 8 for specific cabinet requirements.

Perchloric Acid Hoods

- Any laboratories that will use heated perchloric acid in a process where perchloric acid vapors are not condensed (or otherwise trapped or scrubbed) as part of the process, or those that use concentrated perchloric acid (>72%) shall be equipped with a perchloric acid hood with wash-down system. Contact EHS for guidance.
- Perchloric acid hoods shall not be manifolded with non-perchloric acid hoods.

Gas Cabinets and Exhausted Enclosures

- Any laboratory where toxic or corrosive gases are present must be equipped with a gas cabinet or exhausted enclosure that meets the requirements of NFPA 55.
- Any laboratory where flammable gases are present in excess of the MAQ per NFPA and CT State Building Code must be equipped with a gas cabinet that meets the requirement of NFPA 55.

Snorkels (Extraction Arms)

- Extraction arms for typical laboratory use can be either 3" or 4" depending on application.
- Hoods should be made of clear plastic unless there is need for additional chemical resistance. They can be either dome or square style, depending on application.
- Note: snorkels used in welding applications should be 6" and have spark protection and a compatible hood.

Ductless Fume Hoods

- Only permitted with EHS approval for specific applications (i.e., core facilities with highly repetitive, low hazard processes).
- If allowed, the ductless hood must meet the following criteria:
    - The manufacturer shall meet and provide documentation indicating that the unit can be used with the chemicals in the anticipated concentrations used in the lab.
    - The unit must include a reliable monitoring system that indicates breakthrough at 25% the threshold limit value.

Chemical Storage

The laboratory design must include dedicated space for chemical storage. This can include below-hood and/or free-standing flammable and corrosive chemical storage cabinets as well as shelving.

Flammable Storage Cabinets

- Must have self-closing and self-latching doors.
- Must be labeled "Flammable – Keep Fire Away."
- Must be labeled to identify if they are/are not connected to exhaust.
- Must have door sill raised at least two inches above the cabinet bottom to retain spilled liquid within the cabinet.

- Venting/exhausting of flammable storage cabinets is only required where there will be storage of toxic by inhalation/acutely toxic or malodorous chemicals.
    - If flammable cabinets are vented, they must comply with NFPA 30 and be directly connected to exhaust.
- Metal flammable storage cabinets must be designed to meet NFPA or OSHA requirements, which includes:
    - Bottom, top and sides of cabinet must be at least No. 18-gauge sheet iron.
    - Cabinet must be double walled with one and one-half inch airspace.
    - Joints must be riveted, welded or made tight by some equally effective means.
    - Door must have a three-point latch.
- Wood flammable storage cabinets must be designed to meet NFPA or OSHA requirements, which includes:
    - Bottom, top and sides of cabinet must be constructed of exterior-grade plywood at least one inch thick.
    - Plywood must not break down or delaminate under fire conditions.
    - Joints shall be rabbeted and fastened in two directions with flathead wood screws.
    - When more than one door is used, they must have a rabbeted overlap of not less than one inch.
    - Hinges must be mounted in such a manner as not to lose their holding capacity due to loosening or burning out of the screws when subjected to the fire test.

Corrosive Storage Cabinets

- Must have self-closing and self-latching doors.
- Must be labeled “Corrosive.”
- Must have door sill raised at least two inches above the cabinet bottom to retain spilled liquid within the cabinet.
- Venting/exhausting of corrosive storage cabinets may be required. Consult with EHS.

8. Gas Systems

Fixed Gas Detection

There may be instances where EHS requires fixed gas detection due to the presence of toxic or flammable gases or if there is the potential for an oxygen deficient atmosphere due to cryogens. In these instances, EHS will determine if a system is necessary, where sensors, panels and strobes/alarms should be located. The make/model of all fixed gas detection systems must be approved by EHS.

Compressed Gas Systems

- Manifolded gas systems must meet code requirements.
- All gas cylinder storage and use areas must have permanently affixed mechanisms for securing cylinders.
- Hydrogen gas generation should be considered instead of cylinders for large users. In some building locations, fire code may require local generation. Contact EHS for assistance.

- Cryogens, and large amounts of some other gases (in cylinders), have the potential to displace oxygen if significant quantities are released without adequate ventilation. Contact EHS in advance for review of location and potential oxygen monitoring needs. Laboratory group is responsible for on-going maintenance or calibration of any required personal or fixed area monitors.
- The handle of each laboratory fitting shall be identifiable through labeling and color coding to indicate the liquid or gas that is delivered through such fitting referencing applicable NFPA and CGA standards.

Medical and Veterinary Gas Systems

- Gas storage and delivery systems for medical or veterinary applications (e.g., medical oxygen, anesthetic gas) must be designed, built, and certified to NFPA 99.
- Contact EHS to evaluate any leak detection requirements.

9. Refrigerators and Freezers

- Laboratory grade refrigerators are preferred over household refrigerators.
- Refrigerators and freezers where flammable liquids will be stored must be rated for flammable material storage.
- Recognize the high heat loads generated from most freezers, and place accordingly. Freezer-farm rooms may require additional local cooling.
- Shared ultra-low temperature freezers should be of the style with multiple interior insulated sub-compartments to avoid long door open periods.

10. Regulated Lab Waste

- Sufficient space must be provided in lab spaces for the collection and storage of regulated waste streams including dry and liquid radioactive waste, hazardous chemical waste, and biomedical waste containers.
- Space much be allocated in each laboratory area as all chemical hazardous waste must be kept in the room at or near the point of generation. This should also include space for secondary containment, as it is required to separate hazard classes.
- Fume hoods are not intended as waste accumulation locations and should not be considered such unless directed to do so by EHS.
- Space is needed either on or below bench tops for medical waste and sharps containers for easy access.
- Each floor should have space allotted for the storage of either medical waste boxes or aluminum metal carts (YSM) along with space for the storage of empty medical waste boxes, bags and required labels.
- Each laboratory should have space for normal trash.
- Laboratory recycling containers should be in place where applicable.

11. Specialty Room Design Considerations

Tissue/Cell Culture Rooms

- Under negative pressure relative to corridors and surrounding spaces.

- Separate from surrounding areas with door, preferably inward opening.
- Seamless sheet flooring, raised wall: floor edging.
- Floor penetrations caulked/sealed to prevent liquid migration in emergency.
- Handwashing sink inside room, preferably near door.
- Ceilings at least 8 ft high to accommodate biological safety cabinets and stacked incubators.
- Avoid placing biosafety cabinets below air supply vents; consult EHS for preferred placement.
- Hard-plumbed, manifolded gas delivery system for incubators as required by occupants.

Please Contact EHS for BL2 Plus Tissue/Cell Culture Rooms.

Darkrooms

The following criteria still apply for wet darkrooms:

- Provide additional ventilation to either dilute contaminants or capture locally (especially if wet tray work or using processing equipment with dedicated exhaust).
- Silver recovery system required for effluent from automatic film processors.
- Automated film or photograph processors must be registered with EHS for wastewater discharge permitting with CT DEEP. Such equipment must also be on service contract to ensure regular maintenance.
- DWV pipes should be at least one diameter larger than standard drainage required due to periodic solids loading and recognized tendency of such installations to clog.
- Constant temperature equipment typically needed to maintain water temperatures within 2 degrees of 68 F for wet tray/black and white work, and within 0.5 degrees of 95 F for color work. Confirm with end users.
- Provide footprint/space for waste collection containers.

Laser Labs

If laser is Class 3B, minimum requirements are:

- Laser warning sign on door (EHS produces specific to each room).
- Barrier at entry way to prevent greater than Maximum Permissible Exposures (MPEs).
- Holder for laser protective eyewear (LPE) prior to passing entryway barrier.

If laser is Class 4, in addition to all Class 3B requirements, minimum requirements are:

- Illuminated “Laser in Use” sign at entryway to the laser-controlled area (LCA). LCA is typically the entire room.

Microscope Rooms

If microscope has an open-beam Class 3B or 4 laser:

- Requirements listed above apply

If laser contains fully-enclosed Class 3B or 4 laser:

- LSO should be contacted to verify requirements.

Labs Housing X-Ray Equipment

- Must have “Caution: X-Ray” sign on door.
- If open beam systems are used, must have an illuminated “X-Ray On” light above door.
- Must have access control to the room, ideally keycard access.

12. Lab Commissioning

Prior to officially opening a newly constructed or renovated laboratory space, it is important that EHS, Yale Fire Code Compliance, and Facilities staff have the opportunity to walk-through the area. This final walk-through gives these and other Yale service departments with long-term responsibilities for the space the opportunity to evaluate equipment and conditions, and to ensure that critical building and safety systems (e.g., emergency water, fume hoods, postings and signs) are properly installed before lab occupancy. On sensitive or higher hazard projects, please involve EHS and/or other pertinent support departments for periodic pre-completion site visits.

13. Special Operations

The following kinds of areas and operations carry higher or unusual hazards, and must be designed in conjunction with EHS and other applicable departments:

- Animal research
- Autoclave/glassware washing rooms
- Automated film processors
- Biological safety level 3 (or higher) labs and tissue culture rooms
- Cleanrooms
- Clinical spaces and areas adjacent to related patient care areas, especially those with potential respiratory disease cases, tuberculosis patients, and infectious agent isolation rooms
- Flammable storage rooms
- High magnetic field generating equipment
- Irradiators
- Large teaching laboratories
- Perchloric acid fume hoods
- Radioactive iodine fume hoods
- Confined spaces
- Powered industrial truck and mobile elevating work platform operations
- Cranes and hoist ways
- Robotics

Appendix A: Pre-Construction/Renovation Work

A variety of potentially hazardous materials and/or conditions may exist in spaces or on property planned for renovation or construction. These range from issues relating to existing building systems (e.g., asbestos, lead paint) to materials left behind by former occupants (e.g., chemicals, contaminated piping), all of which require assessment and abatement prior to

project commencement. Although these issues are generally identified and managed by EHS, cost responsibilities for structural abatement work (e.g., asbestos, lead paint, underground storage tank removal) are usually a project budget line item. Early interaction with EHS on these issues will help ensure that adequate lead-times and monies are allocated for the project.

Infrastructure Issues

- Asbestos
- Lead/lead paint
- PCB-containing caulks
- Mercury-containing fluorescent lamps and PCB ballasts
- Mercury-containing thermostat switches
- Excessive mold/mildew, pigeon or other animal excreta, high dust accumulations, and other likely nuisance conditions
- Potentially contaminated waste plumbing, vacuum lines, and/or hazardous exhaust system ductwork (see below)
- Freon recovery from refrigerators and freezers
- Compressed gas cylinder returns
- Underground or above-ground storage tanks
- Potential soil/groundwater contamination
- Smoke detectors containing radioactive sources

Operational Issues

- Historical use of hazardous materials (e.g., biological, chemical, radioactive materials) triggers area and equipment clearance by EHS before work begins.
- EHS surveys must be performed on vacuum lines, waste plumbing, and fume hood ductwork where radioactive materials were previously used.
- Hazardous wastes must be removed by EHS prior to start of construction work.
- Laboratory sink traps and vacuum line traps and elbows may contain small amounts of mercury. Instruct all demolition and plumbing staff to collect initial drain effluent into a pail or bucket to inspect for mercury globules. If present, stop work, set pail aside and notify EHS to remove. Stop work and contact EHS in the event of a mercury spill or contamination.
- Implement dust control and general nuisance avoidance procedures prior to start of work. This includes preliminary assessment of potential impacts during design/ planning phase, evaluating need for an occupant's Community Meeting, and distribution of on-going project "look-aheads" to keep occupants and other relevant departments (e.g., Yale Fire Code Compliance, service/maintenance groups, EHS, Alarm Control Center, etc.) aware of work.
- Biosafety cabinets cannot be moved until gas decontaminated by the Yale contracted vendor. Contact EHS for coordination.

Appendix B: Additional References

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