CONSTRUCTION/RENOVATION GUIDELINES

GENERAL BUILDING DESIGN CONSIDERATIONS

General Building Materials:

Specify no asbestos-containing products. The architect should provide a statement that no asbestos products were specified. Note: many products may still contain asbestos because they were not included in the EPA's 1989 ban and phase-out. These include pipeline wrap, vinyl composite tile, millboard, corrugated and flat cementitious sheets, roofing felt, cementitious shingles, roofing and non-roofing adhesives, sealants, and coatings. Note: the Consumer Product Safety Commission requires manufacturers to label products that contain asbestos.

Specify no heavy metal products (lead, cadmium, mercury, etc.) whenever possible.

Opt for low volatile organic compound (VOC) paints, epoxies, adhesives, fillers, etc.

Specify low or no formaldehyde-containing/emitting products (glues, plywood, insulation, etc.).

Specify no PCB-containing products or equipment.

Minimize carpeting whenever possible, and opt for resilient flooring, tiles, wood, etc.

If carpet will be used, consider modular systems (carpet tiles) with low VOCs using little or no adhesive for installation. Anti-static and anti-microbial features are desirable. Also, ensure Carpet Research Institute (CRI) approved materials (carpet, adhesives, and cushion), installers, and installation methods are used.

Minimize the use of fabric and other porous surfaces with little or no water repellency (rationale: these are apt to collect dust, harbor organisms, and are difficult to clean/disinfect once subjected to water/moisture).

Install protective bollards around all outside fuel tanks and fill pipes in locations where damage from normal vehicular traffic and snowplows can occur.

HVAC:

Reference ASHRAE Standard 62-2001, *Ventilation for Acceptable Indoor Air Quality.*

Design for easy access to all components of HVAC systems, especially mechanical parts and filters.

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Allow ample time for curing and ventilation of products and finishes prior to reoccupancy, e.g., 48 hours of 100% outside air ventilation prior to reoccupancy.

Specify no ethylene glycol coolants; opt for propylene glycol.

Locate air intakes away from potential pollutant sources, e.g., loading docks, dumpsters, cooling towers, exhaust fans, vent pipes, etc.

Install bird screening and other bird roosting deterrents around and near air intakes.

At a minimum, turndown/throttle variable air volume (VAV) boxes must provide 15 - 20 cfm of fresh outside air per person (ASHRAE 62-2001) when the room is in an occupied mode.

Prior to occupancy, replace filter media in HVAC systems.

Reference ASHRAE Guideline 1--*HVAC Commissioning Process*.

For alterations and renovations, reference SMACNA guidelines, *IAQ Guidelines for Occupied Buildings Under Construction*.

Interior insulation/lining of HVAC systems is not recommended. If sections must be lined for acoustical reasons, use non-porous or low-porosity, durable materials that do not support microbial growth, per ASTM, UL, etc.

Consider heat recovery/ free cooling systems to maximize delivery of outside air while promoting energy conservation.

Maximize individual environmental control through enhanced zoning, i.e., systems that allow occupant adjustment of temperature *and* airflow.

Humidification, if provided, must be via dry, clean steam, or other economically viable methods. The humidifier section must be downstream of heating coils. Any porous duct liner/insulation must be located at least fifteen (15) feet downstream of the humidifier section. Access for inspection must be available for the humidifier section.

Opt for ducted returns rather than plenums.

Opt for high efficiency air filters (ASHRAE 52.1-1992 Dust Spot 40% or greater), such as extended surface types (pleated, bagged, enhanced media). Supplement with lower efficiency prefilters.

If gas lines are installed, locate vent pipes away from air intakes; this includes purge lines from boilers, etc. Seek gas company guidelines on a case-by-case basis.

In mechanical rooms that have the potential for releases (e.g., Freon®, ozone), consider alarms or emergency signals to alert building occupants of releases. Reference ANSI/ASHRAE 15-1994, *Safety Code for Mechanical Ventilation and Addenda.*

LABORATORY BUILDINGS

The building should be equipped with:

Emergency electrical service to ensure the continual operation of: fire alarm systems and pumps; egress lighting and signs; emergency lighting in hallways, laboratories, and rest rooms; an emergency communication and evacuation system; exhaust and make-up fans connected to critical ventilation systems and all other systems with critical health and safety functions.

Portable fire extinguishers installed in hallways; type and number based on Fire Department recommendations.

Consideration should be made for access-controlled areas; in high-risk areas, access should be limited to individuals specifically assigned to work in that area, e.g., card key access or combination lock access, etc.

Posted fire escape routes. Emergency egress routes should be continuous and unobstructed.

Neutralization (limestone) tanks should **not** be installed (or used) to treat acid wastes before they enter the sanitary sewage system. Likewise, a pH monitoring system is not necessary, since all hazardous wastes are picked up weekly by Environmental Health and Safety (EH&S).

Emergency power/generators; locate generator exhausts away from supply air intakes.

A room serving as a Command Post where the Fire Department can access Material Safety Data Sheets (MSDS), shut off building alarm(s), and shut off electrical/gas utilities.

Laboratory spaces should be provided with:

A fire, smoke, and heat detection alarm and suppression system (water sprinkler, unless contraindicated); wet and dry suppressor systems shall be evaluated on a case-by-case-basis by the Fire Department. The emergency evacuation alarm should sound on a building-wide basis, and be wired into the Fire Department.

First aid kits, which should be minimally equipped with Band-Aids and gauze to encourage reporting injuries to Student Health Services.

Portable, wall-mounted fire extinguishers installed adjacent to room exit(s).

An area WITHIN each laboratory to collect and store chemical wastes prior to the weekly waste pick-up by EH&S.

An area for chemical storage where incompatible chemicals can be segregated according to their class, e.g., oxidizer, reactive, corrosive, flammable, etc. Racks should be securely anchored to walls, and shelves built with a ¾-inch lip on the edges. The storage area should include:

> An approved, corrosive storage cabinet (if needed); an NFPA/OSHA/FM-approved, non-vented flammable liquids storage cabinet(s); a ventilated cabinet for the storage of highly toxic/carcinogenic or odorous materials; and an NFPA-approved flammable liquids refrigerator (if needed). [NOTE: Flammable storage cabinets are designed to protect the contents of the cabinet from a room fire. NFPA has stated that the integrity of the cabinet (and its insulating properties) is compromised when openings are present]. All solvent storage units should be electrically grounded.

A compressed gas cylinder storage system ensuring rigid and secure supports for gas tanks in use; segregated and labeled locations for full and empty cylinders in storage. Full cylinders should be stored in a mechanically ventilated storage area.

Emergency information posted on the exterior of doors; the information should be clearly visible from the hallway and include:

> The department's name; room number; faculty member(s) responsible with office phone number(s); laboratory occupant(s) name(s) and home phone numbers(s); emergency phone numbers for fire/police/ ambulance, Facilities Operations (Work Order Control), Environmental Health and Safety, and the Student Health Services. [Home phone number(s) may alternatively be filed with the Fire Department instead] Note: EH&S has pre-printed yellow cards to serve this purpose.

Chemically resistant sinks with a removable strainer should be used. All sinks should be provided with hand soap (liquid dispenser preferred) to encourage hand washing after chemical work is completed.

A backflow preventer on the water supply, with a relief valve and open drain to prevent laboratory water systems from contaminating drinking water.

Work surfaces sized to permit safe access to utility outlets, and within easy reach of storage units located above the work area. The standard work surface depth is 2 feet. Deeper surfaces may be necessary to support large equipment.

Major aisles between benches, with a minimum clearance of 5 feet, to permit safe passage of persons behind those working at a bench.

Desks must not obstruct laboratory egress. If needed, they should be isolated from wet laboratory operations, e.g., an anteroom for each lab as in the Chemistry Building.

Consider allowing space for a meeting area, eating area, and other non-laboratory functions.

A chemically resistant, impervious floor covering that is also resistant to slipping.

All utilities (electrical, water, steam, gases, etc.) with emergency shutoffs located on the wall just outside the laboratory, if feasible. The panel should have an easily removable cover and a clear sign indicating its function. All utility pipes should be clearly identified by color and name. Electrical panels should be unobstructed and each circuit breaker function clearly labeled. An inventory of electrical supply needs for various instruments/equipment should be made.

All utilities running through a service chase, which allows for at least 25% extra space for future additions.

Ground-fault circuit interrupters installed on all laboratory benches near wet operations, and where portable equipment is used.

An emergency deluge shower operated by a rigid, chemically resistant pull bar attached to a stay-open ball valve delivering a minimum of 30 gallons-per-minute at low velocity. Showers should deliver tempered (70-90 degrees F) water to permit a 15-minute shower. The pull ring should not be located more than 77 inches from the floor (except handicapped workers may need individual determinations); the shower head should be at least 84 inches from the floor; the horizontal distance from the center of the head to the pull bar should not exceed 23 inches; tempered water showers should have an anti-scald mixing valve. Reference the current ANSI (Z358.1-1990) standard for specifications.

Emergency deluge showers located just outside the hazardous area within 10 seconds travel time or 100 feet travel distance from any point. They should not be placed in front of chemical storage areas or fume hoods. A possible location could be in a hallway, as long as the 100-foot/10 seconds maximum travel distance/time is not exceeded, and the pull bar is located close to a wall so it does not interfere with normal traffic. Enough wall clearance is needed to permit a second person to move around and help. A large contrasting sign should be affixed to the wall and an area of the floor painted directly beneath the shower to keep the area unobstructed.

A plumbed emergency eyewash located within 10 seconds travel time or 100 feet travel distance in an area where corrosives, strong irritants, and solvents are used. Since a 15-minute wash is recommended prior to transportation to a medical facility, the water should be tempered to 70+/-5 degrees F. An anti-scald mixing valve shall be used on tempered units. The unit should have a stay-open ball valve supplying 3-7 gallons per minute.

A method within laboratories to segregate different categories of waste, e.g. combustibles, non-combustibles, glass, metals, etc.

A vented, designated area for the use and storage of cryogens, e.g., liquid nitrogen.

Excess flow check valves (flow limit valves) incorporated into pressurized gas delivery systems where toxic or flammable gases are piped to an area; these devices shut off the gas flow if a preset flow rate is exceeded.

Laboratory ventilation systems:

Reference the current version of the ACGIH *Industrial Ventilation Manual.*

A comfort ventilation system to maintain design temperature, humidity, and breathing air quality; 4-12 air changes/hour, per OSHA 29 CFR 1910.1450

An exhaust ventilation system designed specifically for health and safety protection with all (100%) laboratory air exhausted to the outside with no recirculation occurring. Laboratories must be under negative air pressure with respect to non-laboratory areas. Air from non-laboratory areas can be recirculated so long as the minimum amount [the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) recommends 20 cubic feet per minute (cfm)/person in occupied mode] of fresh, outside air is supplied to maintain occupant health.

A low velocity, mechanical make-up air system to replace the volume of air exhausted to the outdoors. Air velocity at the occupant's level should not exceed 50 feet per minute (fpm).

Laboratory fume hoods located away from major traffic routes, supply and return air diffusers, door openings, emergency exits, etc. to minimize air turbulence at the hood face.

When a researcher is positioned in front of the hood, an average face velocity of 100 fpm must be maintained. Face velocities should not drop below 60 fpm to ensure adequate capture of contaminants, nor exceed 120 fpm to avoid excessive turbulence.

For buildings with laboratory hood use, energy-efficient systems should be required, including fume hood controls that detect the presence/non-presence of a user. Each hood equipped with a continuous monitoring device, and an externally mounted audible and visible low flow alarm that activates when the face velocity drops below 60 fpm. The sensor functions automatically by varying the exhaust fan speed to maintain a constant average face velocity of 100 fpm regardless of the sash height (opening).

Hoods with horizontally movable glass panels incorporated into the vertically sliding sash to provide an extra margin of safety by providing shields when the full height of the sash opening is not needed.

All utility controls and electrical receptacles should be mounted on the exterior face of the hood. Hood wiring should incorporate ground-fault circuit interrupter (GFI) protection for all receptacles, the lighting switch, and lighting fixture.

Where hoods in different areas or rooms are served by the same exhaust fan, on/off controls should be wired in such a manner to require <u>all</u> switches to be in an "off" position in order to deactivate the fan.

Perchloric acid hoods must be dedicated, and labeled "For Perchloric Acid Use <u>Only</u>." Hoods and ductwork should be acid resistant, non-reactive, and impervious to perchloric acid, e.g., stainless steel. Fans should be acid resistant and non-sparking. Ductwork should have water spray capabilities to wash the hood, fan, and the entire duct system.

All hoods with an attached label indicating which exhaust blower serves it; each exhaust blower with an attached label indicating which hood(s) it exhausts. Fans and drive belts should be located external to the ductwork.

Ductwork that follows the <u>shortest</u> and <u>straightest</u> route to the outside. Horizontal duct runs should be as short as possible, and runs should be contained within chases interior to the facilities.

Specify no flexible duct to be used in laboratory exhaust construction.

Sealants, gaskets, sleeve couplings, etc. should be constructed of acid-resistant and non-reactive material.

Specify no sheet metal joints in laboratory exhaust duct construction.

Exhaust fans mounted on the rooftop or in a ventilated penthouse to keep ductwork within the building under negative air pressure, and thus minimize the leakage of contaminated exhaust into occupied spaces. Fan motors must meet CL & P requirements for efficiency.

Exhaust stacks securely anchored, extending at least 10 - 12 feet above the adjacent roofline and exhausting in a vertical direction to minimize stagnation of contaminants near the roof area and achieve optimal atmospheric dilution. For manifolded systems of 5 or more hoods, consider extending the stack to 20 feet. The stacks should have a discharge velocity of at least 2,500 fpm.

All fresh air intakes in locations <u>remote</u> from laboratory hood exhausts, loading docks and other potential pollutant sources to avoid the short-circuiting of exhaust air and the re-entrainment of contaminants into the building supply air system.

Utilize a fume hood "vertical discharge/no loss" stackhead design, as specified in the ACGIH ventilation manual, with an upper stack to minimize rain and snow from entering the exhaust system.

Avoid the use of canopy (overhead) type of hoods since these bring contaminants past the user's breathing zone on their way to being exhausted. Canopy hoods can be used for thermal processes to take advantage of rising air currents. However, if toxic vapors are being generated, the hood must be positioned between the source and the person's breathing zone.

When equipment size or a particular process precludes the use of a laboratory hood to safely and adequately exhaust contaminants, a spot (high velocity-low volume) local exhaust may be installed. Such set-ups require an exhaust system that is separate from the one serving the hoods. Flexible ducts for spot local exhaust should be non-collapsible and of minimum length due to its high resistance to airflow. Long runs and abrupt changes in direction can increase resistance resulting in severely reduced function. Local exhaust to remove heat and humidity should be a consideration in autoclave and glassware washing rooms.

Exhaust fans constructed of fiberglass-reinforced polyester are highly recommended for air containing large amounts of corrosive gases and water vapor. Explosion-proof fans are required when it is possible for the effluent air to contain more than 25% of the lower explosive limit of any combination of vapors and aerosols.

When belted exhaust fans are used, they should be double-belt cog driven; have standard grease fittings for shaft bearings lubrication; a drain at the low point of the scroll casing, and equipped with vibration isolators. Belts should be a matched set, rated at 150% of capacity with drives as short as possible.

Exhaust ducts should be of the high-velocity type to avoid particles settling in horizontal runs. Stainless steel is necessary for corrosive applications. Epoxy-coated steel or galvanized metal can be used for less corrosive operations. Ducts should be constructed of <u>round</u> piping with smooth interiors and airtight (welded or sealed) joints, and equipped with smoke detectors connected to the building's fire detection system.

Keeping duct velocities within acceptable ranges (2000-3000 fpm) will also minimize air noise in laboratory ductwork, as will the use of flexible connectors between fans and ducts.

Biological Agent Laboratories – Additional Considerations:

Purchase and installation of biological safety cabinets requires pre-approval by Biosafety and/or the Institutional Biosafety Committee. Biological safety cabinets shall NOT be hard connected or thimble connected to building ventilation, unless approved by the EH&S Biological Safety section. BEFORE FIRST USE, Biological safety cabinets must be tested and balanced for proper inward and downward airflow, and be re-certified on an annual basis by an NSF certifier approved by Biological Safety.

Used biological safety cabinets to be moved to renovated or new laboratories must be re-certified in place after relocation and prior to use. Biological safety cabinets should be positioned away from high traffic areas, windows that can open, smoke alarms, sprinkler systems or air supply vents. There should be no less than one-foot clearance between the exhaust grill of the cabinet and the ceiling. Any modifications to biological safety cabinets that will penetrate cabinet walls void the manufacturer's warrantee and make the unit uncertifiable. Gas and or vacuum shut-offs should be external to the cabinet.

When an area to store biohazardous waste is not possible within each laboratory, there should be easily accessible, centrally located space (such as an autoclave/glassware room or walk in cold room) elsewhere on the same floor to store such waste prior to the weekly waste pick-up by EH&S.

Laser Laboratories – Additional Considerations:

In order to ensure controlled access, all laboratories containing lasers (Class III or greater) must be equipped with secure, lockable doors.

Labs in which Class 4 lasers are utilized require either the installation of laser shutdown door interlocks or an illuminated laser activation warning system exterior to the lab. Labs in which Class 4 lasers are utilized may, depending upon the laser exposure levels, require the installation of blocking barriers, screens, curtains, window coverings, etc., which can withstand direct and diffusely scattered laser beams.

Labs using certain Class 3 and Class 4 lasers may generate air contaminants when the laser beam interacts with matter. In such instances, these laser-generated air contaminants (LGAC) necessitate the installation of appropriately designed ventilation systems.

Radioisotope Laboratories – Additional Considerations:

In order to ensure controlled access, all laboratories containing radionuclides and/or x-ray producing equipment must be equipped with secure, lockable doors. The doors, intended to control access, shall be designed to allow both rapid egress and admittance under emergency conditions.

Laboratories using radionuclides must have the proper posting of hazards on associated equipment, hood, exhaust fan, exterior laboratory door, storage areas, and potentially contaminated work areas, as required by the Radiation Safety Committee.

Radioactive "hot" labs, radiosynthesis, or iodination labs should have a stainless steel bench top or covering, where feasible.

Radioactive "hot" labs, radiosynthesis, or iodination labs should have one, designated stainless steel sink for sanitary sewage disposal, and must be equipped with drain lines made of plastic Labline®, or equivalent. The plastic drain line should be enclosed within an outer plastic drain line, where feasible; an automated leakage indicator should be installed, where feasible. The designated sinks should have floor-mounted or foot-operated pedals to operate the faucets, in addition to standard hand-operated faucets.

Radioactive "hot" labs, radiosynthesis, or iodination labs, should have resilient sheeting or resinous flooring to provide a seamless surface and to prevent penetration to the underlayment. No tiles should be used.

Iodination facilities should be fitted with pre, HEPA, and charcoal filters with an automated indicator alerting users of the need for filter changes. The iodination hood/filter housing should be adapted with room air, pre and post filter housing sampling devices. All ductwork, exhaust fans, and/or associated ventilation system must be posted with proper, "Caution Radioactive Materials" signage.

Radionuclide/iodination hoods labeled, "Caution Radioactive Material." Hoods and ductwork should be stainless steel and equipped with interior sampling ports to room, pre, and post filter housing. Ductwork must have a particulate pre-filter, HEPA filter, and activated charcoal filter. Fans and filter housings must be located near or (e.g., fan loft) on roofs to ensure the complete system is operating at a negative pressure with respect to the interior of the building. All ductwork, exhaust fans, and/or associated ventilation system components must be posted with the proper, "Caution Radioactive Materials," signage.

An area physically separated from the chemical wastes should be included to contain mixed (radioactive <u>and</u> chemical) hazardous wastes, where necessary, and stored in mixed radioactive waste storage containers within approved cabinets or fume hoods as specified in the general laboratory equipment section.

FOOD SERVICE ESTABLISHMENTS

All food service establishments must complete and submit a food service plan review application with a sample menu, or a listing of the food items planned to be offered, seating capacity, and projected daily meal volume (number of meals per day) to EH&S prior to any construction of new or renovated food service operations. A professional food service consultant must prepare these plans. Food service plan review is recognized as an important food program component that allows EH&S to ensure that food establishments are built or renovated in accordance with the current Connecticut

Public Health Code and University Food Service Policies. Proper plan review also assists food service establishments in establishing and maintaining an organized and efficient flow of food though the restaurant; helps eliminate code violations prior to construction; and reduces the risk of foodborne disease outbreaks. In addition, a food service plan review helps to avoid future problems; addresses potential problems that can be detected during the design phase; and allows modifications to be made before costly purchases, installations and/or construction occur.

General requirements:

Provide professional plans that include the listing and location of all equipment on the floor plan and the diagramming specifications (cut sheets) for electrical, mechanical, and plumbing systems. Minimum scale should be ¼ inch = 1 foot.

All food service equipment that have a potable water line and sewer drain line connection must be properly connected to prevent backflow/back siphonage. Cross-connections shall be prevented through indirect connections (air breaks or air gaps) and/or backflow prevention devices based on the type of food equipment, per Section 19-13-B42 of the Connecticut Public Health Code.

All floors and walls in the kitchen area must be constructed of a washable, durable, non-absorbent, and stain-resistant material. Painted drywall is not an acceptable wall finish material, since it is not durable enough to withstand damage and/or repeated washing. Washable, non-absorbent, light colored ceiling materials are also required. Carpeting is not allowed in any of the kitchen areas, except in the dining rooms.