

University of Pittsburgh Professional Design Manual

DIVISION P LABORATORY DESIGN STANDARDS

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Section P.1: Applicability of the Laboratory Standards


A. General

1. The following are general guidelines established as minimum criteria to be used by professionals for design of research and teaching laboratories located in University of Pittsburgh-owned buildings or leased facilities used by University of Pittsburgh faculty and/or researchers.
2. It is acknowledged that depending on their proposed use, some of the needs of individual laboratories may differ from others and these Standards are not expected to cover all issues or conditions that arise in the process of designing each individual laboratory. Rather, the purpose of the Standards is to address the laboratories' most common issues and needs, with the understanding that conditions unique to each project must be addressed and resolved during the design process with the input of the laboratory Users and other University entities as applicable.
3. It is expected that from time to time these Standards will need to be revised or updated. Responsibility for issuing and updating the Laboratory Design Standards resides in the University of Pittsburgh, Office of Facilities Management. Requests for revisions must originate from the University Head of the Department requesting the revision, it must be sent in writing to the Associate Vice Chancellor—Facilities Management for consideration, and it must include the requested change, justification, an assessment of the additional costs/savings (if any) and other advantages (added safety, security, energy conservation, etc.) resulting from the proposed revision of the Standards.
4. These Standards are not designed to supersede the laboratory equipment manufacturers' installation requirements for specific pieces of equipment. The Professional shall design and specify the commissioning of the laboratory equipment to comply with the installation recommendations of the manufacturer of the specific equipment to be housed in the lab. If there is a conflict between the manufacturer's recommendations and the requirements of these Standards, the Professional shall bring this issue to the Project Manager's attention for resolution during the design stage of the project.

B. Definitions

1. For the purposes of these standards, a laboratory shall be defined as an area of a facility with the intended purpose to manipulate laboratory chemicals, biological, animals, or radioactive materials for research, teaching, or diagnostics activities. These criteria are not intended to be applied to research, teaching or diagnostic activities that are void of the hazards listed above, such as "computer labs".
2. The terms "Project Manager" and "PM" throughout the text, refer to the University Office of Facilities Management Project Manager or the UPMC Project Manager responsible for the implementation of the laboratory project.
3. EH&S is the University Office of Environmental Health and Safety.
4. Throughout the standards, "**shall**" and "**must**" are used to designate features which are essential, while "**should**" is used to designate features which are recommended but which are not pre-requisites for design approval by the University.

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5.  Paragraphs which are followed by this symbol indicate the University's ongoing commitment to sustainable practices.


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Section P-2

A. General

Division P-1, Sections A and B, "Applicability of the Laboratory Design Standards" is hereby made part of this Section by reference.

The following are general guidelines established as minimum design criteria for research and teaching laboratories at the University of Pittsburgh. These criteria are not all inclusive but are intended as basic parameters for laboratory design. See Sections D, E and F of these Standards for specialty usage laboratories such as research animal spaces, Bio-safety Level 3 (BSL3) laboratories, lasers and magnets.

- A.1. Laboratories shall be fully enclosed by walls and doors and separated from egress paths, general offices, receiving areas and other areas where there is ready access to the public and public thoroughfares.
- A.2. Laboratory equipment shall not be installed or utilized in **egress** corridors.
- A.3. EH&S recommends that laboratories be designed with a minimum of 50 square feet per laboratorian. Consideration should also be given for ample storage space for consumable lab supplies and allow space for the variety of waste collection containers needed. Depending on the laboratory, these may include laboratory trash, broken glass, sharps, recycling containers, used oil, medical waste, chemical waste and/or radioactive waste. 
- A.4. Laboratories shall be designed with adequate work counter and equipment space, and access to adequate electrical service. Extension cords and multi-outlet devices are not permitted as part of standard lab design.
- A.5. All penetrations in walls, floors and ceilings shall be permanently sealed around openings for fixtures, conduits, and utility lines to separate the lab from interstitial space and for pest control.
- A.6. Lounge, locker, and toilet facilities shall be located outside the laboratory.
- A.7. Food and drink are prohibited in laboratory areas. This principle must be considered when designing laboratories and associated work stations and offices.
- A.8. Laboratories using compressed gases should have dedicated areas for cylinder storage and be equipped with devices to secure cylinders in place.
- A.9. Laboratory design shall comply with ADA requirements.

B. Walls, Floors, and Ceilings

- B.1. Penetrations in walls, floors and ceilings for electrical, plumbing and other considerations shall be completely and permanently sealed.
- B.2. Perimeter walls shall be of solid construction, covered with a surface that is smooth and cleanable and coated with a chemical resistant finish.
- B.3. Floors shall be covered with a material that is slip resistant, smooth and cleanable.

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- B.4 In labs using bio-safety level 2 or higher agents, ceilings shall be covered with a material that is smooth and cleanable.

C. Doors

- C.1 Doors to laboratories shall be fitted with latching hardware and have a minimum fire rating of 20 minute construction.
- C.2 Laboratory doors shall be automatically self-closing. Depending on the amount of large equipment to be used in the lab, consideration should be given to the provision of doors with side panels that would provide clearance for large pieces of equipment.
- C.3 If security locks are required on doors leading to exit access, only University approved security locks meeting with applicable Codes shall be installed. Security locks shall allow the doors to be readily opened from the laboratory side at all times without the need for keys or cards or the need to use both hands to operate the latching mechanism.
- C.4 Doors shall be posted with a room number for ease of identification and allow space adjacent to the jamb for a hazard warning sign to include a list of significant hazards and emergency contact information as required by the University, and also "AUTHORIZED PERSONNEL ONLY" at all lab entries.
- C.5 Each door from hallway into lab should have a view panel to prevent accidents from opening the door into people on the other side and to allow individuals to see into the laboratory in case of an accident or injury. Consideration should also be given to the provision of bottom door seals to keep corridor dust from infiltrating into lab spaces.

D. Windows

- D.1 It is recommended that windows in laboratories be inoperable and/or sealed in a shut position.
- D.2 If windows in laboratories are capable of being opened, they shall be provided with insect screens. It is recommended that these windows remain in the closed and locked position.

E. Casework and Furniture

- E.1 Fixed or movable laboratory equipment and/or furniture shall not interfere with minimum aisle clearances required by Code. Lab benches shall not impede emergency access to exits.
- E.2 Bench-tops shall be impervious to water and resistant to moderate heat, organic solvents, acids, bases and chemical disinfectants at a minimum. Countertops should incorporate a lip to help prevent run-off onto the floor. All countertop surface penetrations such as electrical conduits, plumbing pipes, etc. shall be completely and permanently sealed to prevent liquids from running down these elements.
- E.2 Bench-tops or associated back-splashes shall be installed tight-to-wall and sealed at the wall/bench junction.
- E.2.1 If the case work is movable, it is recommended that ample space be provided to allow for frequent relocation of casework as needed for thorough cleaning.



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- E.3 Spaces between cabinets, casework, fixed furniture and other equipment shall be easily accessible for cleaning and decontamination.
- E.4 Drawers shall be equipped with “catches” which prevent the drawers from being pulled out of the cabinet during normal operation.
- E.5 If shelves are accessible from opposite sides, a toe-guard or center birm shall be provided to prevent pushing stored items off shelf at opposite end.
- E.6 In most applications, storage cabinets with doors are preferred over open shelving.
- E.7. Chairs within the lab, especially those for bench-work shall be covered with a material that is impervious to liquid and easily decontaminated by liquid disinfectant.
 - E.7.1 Chairs shall be adjustable to minimize repetitive stress injuries.
- E.8. Each laboratory must be equipped with a sink that has hot and cold running water dispensed from a mixing faucet. This sink must be connected to the building plumbing system by direct connection. Provision should be made for disposable hand towels and liquid soap stored in dispensers which protect these items from contamination.

NOTE: Other features of the hand washing station may be required in certain laboratories utilizing potentially infectious or hazardous materials. Hand washing sinks for particularly hazardous chemicals, biological or radioactive agents may need elbow or electronic controls.
- E.9. Sink faucets and hose bibs that are intended for use with attached hoses should be provided with back siphon prevention devices.
- E.10. Laboratory sinks shall have lips that protect sink drains from spills

F. Utilities

F.1. Electrical power

- F.1.1 All electrical outlets, circuits, and controls must be of sufficient number, size, and capacity (amps) to account for intended uses in the laboratory and to eliminate the need for extension cords and multi-plug assemblies.
- F.1.2 All circuit breakers, switches, panels, and controls servicing the laboratory shall be properly labeled and covered, and shall be located outside the laboratory. All panels shall be equipped with integral Transient Voltage Surge Suppression (TVSS).
- F.1.3 Illumination must be adequate for all activities. It is recommended that minimum 70 foot candles of light be provided at all work surfaces. 
 - 6.1.3.1 Lighting shall be equipped with control mechanisms (occupancy sensors) to turn off portions of lab space not in use, particularly in large shared lab space. 
- F.1.4 All life safety systems supporting the laboratory and other critical lab components as determined by the User shall be supported with emergency

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power. Provide a minimum of one fixture on normal/emergency power near the exit of each lab space.

- F.1.5 Outlets providing emergency power shall be clearly labeled and red in color.
- F.1.6 Electrical outlets within 6 feet of water sources shall be equipped with Ground Fault Circuit Interrupters (GFCI). All outlets controlled by a GFCI shall be labeled accordingly.
- F.1.7 All fume hood exhaust fans and -80 degree freezers shall be on emergency power.
- F.1.8 Each bio-safety cabinet shall be on a dedicated circuit.

G.2 Fire Protection/Prevention

G.2.1 All new laboratory facilities shall be equipped with wet sprinkler systems. Sprinklers shall also be provided in significant renovation projects that involve construction or demolition of walls.

G.2.1.1 Sprinkler heads shall be positioned according to NFPA Guidelines.

G.2.1.2 Fixed equipment shall be positioned to allow for at least an 18 inch clearance between the tops of fixed equipment/furniture and the level of the sprinkler. Exceptions are made at the perimeter of the room.

G.2.2 A portable fire extinguisher of appropriate class as determined by the use of the laboratory, shall be located within 75 feet of the furthest distance of the laboratory or 10 feet of any approved flammable material storage room.

G.2.3 If the User indicates the presence of flammable liquids in vessels larger than 1 gallon in size or intends to store more than 10 gallons of flammable liquid in the laboratory, an approved flammable material storage cabinet with the appropriate fire rating shall be provided.

G.2.3.1 Flammable material storage cabinets shall not be located in egress corridors or public areas. Their placement as base cabinets for chemical fume hoods is NOT recommended, but may be accepted if other alternatives are lacking.

G.2.3.2 It is generally recommended that flammable material storage cabinets not be vented. An approved flammable material storage cabinet has bung covers over each ventilation port, is equipped with a positive latching mechanism on the doors, and is labeled "flammable".

G.2.3.3 Upon User request or as requested by EH&S based on exposure data, flammable material storage cabinets can be vented with EH&S approval. Approved venting utilizes the ports on the cabinet and the duct must have fire resistive qualities equal to or greater than the cabinets. Non-metallic duct material cannot be used for venting. The vent should be threaded into the upper port with the lower port opened and flame arrestor intact. The cabinet should not be altered in any other manner.

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- G.2.4 All new lab facilities shall be equipped with audible and visible signaling devices connected to the building's emergency alarm system. Environmental chambers where evacuation or other alarms cannot be heard shall be equipped with strobe lighting or additional alarms.

H. Plumbing

- H.1 Each laboratory should be equipped with an emergency eyewash station or emergency eye, face and body wash. EH&S recommends a dual nozzle eye, face and body wash, which is counter-mounted near the hand sink. A mixing valve or the provision of tepid water from emergency equipment is required. It is typically not recommended that overhead full body showers be installed within research and teaching laboratories at the University, unless a very large quantity of corrosive liquid is anticipated to be stored and/or utilized.

H.1.1 GENERAL GUIDELINES

- H.1.1.1 All plumbed emergency equipment shall be provided with potable water.
H.1.1.2 All plumbed emergency safety equipment shall be installed with a mixing valve to provide tempered water to avoid additional discomfort of user
H.1.1.3 All plumbed emergency equipment shall be accessible and capable of activation.
H.1.1.4 Only plumbed emergency equipment is acceptable at the University. Bottled water sources are not approved eye wash or emergency shower devices.


H.1.2 EMERGENCY SHOWERS

- H.1.2.1 Emergency showers are not only needed in limited areas in a typical academic research environment due to small chemical volumes in use. One per floor or one per ballroom lab is typical. Consult with EH&S and refer to User Chemical Information List for hazards that create a need for additional showers.
H.1.2.2 Install full body emergency showers in common or central areas outside the laboratory. Emergency showers outside the laboratory can be equipped with floor drains.
H.1.2.3 Emergency showers within the laboratory are not typical, but when installed within a laboratory, a floor drain is prohibited.
H.1.2.4 Emergency showers must be installed in a manner to easily achieve annual testing.
H.1.2.5 Emergency showers will provide water flow as specified by national codes and standards.

H.1.3 EYE WASHES (AND HAND-HELD EYE, FACE AND BODY WASH UNITS)

- H.1.3.1 The University recommends eye, face and body wash units near all locations where hazardous materials are handled. A general rule of a 10-15 second travel distance is applied from source of hazard to eye, face and body wash unit.
H.1.3.2 The unit must have a dual eye nozzle.
H.1.3.3 The unit should be installed at the counter-top in the lab with a retractable hose, as allowable by design.
H.1.3.4 The unit must achieve hands free operation. By definition, this means that the unit operates continuously upon an activation step (until the unit is turned off by separate motion.)
H.1.3.5 The unit must have end caps over the nozzles to prevent contamination that easily release upon unit activation.
H.1.3.6 The unit should be installed near a sink or drain (non-floor drain) to make it conducive to the required weekly testing by the user.
H.1.3.7 Water pressure from the unit should achieve a vertical flow 6-12 inches in height upon operation.

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H.2 It is recommended that floor drains not be installed within laboratories, particularly those using hazardous chemicals or BSL3 agents. 


H.3 When ice machines are requested by the User, they shall be installed per Health Codes with an indirect drain connection. Ice machines within labs must be labeled as “NOT FOR HUMAN CONSUMPTION”.

H.4 Ice machines and other plumbed equipment are not recommended for installation in egress corridors.

H.5 Heating, Ventilation and Air Conditioning Systems

H.5.1 All laboratory ventilation shall be “single pass air” and must not re-circulate to other areas of the building.


H.5.2 As a general principle all laboratories should have air flow which is negative to the surrounding corridors, offices and other public spaces. Supply and exhaust diffusers shall be positioned to ensure air flow and air change rates are adequate within the room. In general, laboratories must maintain a minimum air flow of 6-10 air changes per hour. Occupancy sensors shall be used to decrease the air flow to 4 air changes per hour when the laboratory is not occupied. In an unoccupied mode, the air flow may be reduced to 4 air changes in select situations. The Professional shall consult with the Project Manager regarding this matter.

H.5.3 Each laboratory should be equipped with a supply vent, located in a manner which directs supply air away from the face of biological safety cabinets, fume hoods, incubators and other primary containment devices. 

H.5.4 In the design of outside air intakes, consideration must be given to continuous operation and adverse weather. Rain and snow must be baffled out of the system. Also, consideration must be given to sources of air contamination such as vehicle exhaust, smoking areas, and building exhausts.

H.5.4.1 Air intake shall be separated as far as practical from points of exhaust.

H.5.5 Each laboratory should be equipped with an exhaust diffuser which sufficiently provides the necessary ventilation rates. Exhaust diffusers should be placed to minimize dead spaces (voids of air circulation) and maximize ventilation.

H.5.6 All air exhausted from laboratories shall be discharged to the outside clear of the building via exhaust stacks on the roof. All exhausted air must pass through a heat recovery system. Each heat recovery installation shall be reviewed by the University mechanical engineer to determine the feasibility of the application. 

H.5.7 In general the capacity of the exhaust system fan motor and drive should be 15% greater than capacity of the supply air stream.

H.5.8 For new construction and/or major renovations, a process water cooling loop through a heat exchanger shall be provided to serve all lab equipment requiring cooling. Process cooling shall be served via heat exchanger off of the central cooling system. Smaller renovations shall have localized heat exchanger connected to the central chilled water system. Any lab equipment requiring chilled

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water for cooling as outlined above shall have a backup source of cooling (dx unit, city water, etc.)

- H.5.9 The installation of devices that are interconnected with the exhaust air flow and are intended to purge the laboratory air in the event of a chemical related emergency is only recommended in very limited instances, as required by the volume or specific type of chemicals proposed for the laboratory. Professionals shall review any intended use of this feature with the PM, EH&S and the User to justify the installation of such an enhancement. If it is determined that there is a legitimate need for this feature, the Professional shall locate the activation device near the exit door from the lab and shall specify a sign to be installed adjacent to the activation device stating the following:


"EMERGENCY EXHAUST"

WARNING: Emergency use only. Activation during normal lab operations may lead to unsafe ventilation conditions.

I. HVAC Equipment

- I.1. Biological safety cabinets and chemical fume hoods shall be located away from doors, away from room supply ventilation, operable windows and remote from heavily traveled laboratory areas.
- I.2. Biological safety cabinets and chemical fume hoods should not be used as the sole source of room exhaust.
- I.3. Autoclaves require specialized exhaust to remove heat and moisture, a floor drain with an indirect plumbing connection to the autoclave, electricity, hot and cold water, and steam. Additional specifications are available from EH&S regarding autoclaves.

I.4. Chemical Fume Hoods

- I.4.1 All chemical fume hoods shall produce sufficient capture and containment of hazardous chemicals generated under proposed conditions of use. Existing fume hoods shall maintain 80 to 100 feet per minute with an 18" sash opening. All new installations of chemical fume hoods shall be commissioned to the ANSI/ASHRAE 110 Standard to verify chemical containment. This commissioning test takes into account tracer gas control under both static and dynamic conditions considering cross drafts, make-up air provisions, and laboratory layout and lab traffic. With this commissioning, containment of chemical emissions can be achieved with hood flows as low as 60 fpm; however face velocities exceeding 150 fpm are likely to cause turbulent air flows and loss of containment.
- I.4.2 Where interior cup sinks are requested by the user, the lip of the cup sink shall be elevated to prevent spilled material from entering cup sinks.
- I.4.3 EH&S strongly advises against fire protection systems within chemical fume hoods and associated exhaust ductwork. 
- I.4.4 EH&S recommends a review of intended chemical use for each fume hood installation to determine if a dedicated hazard exhaust system is required per

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guidelines set forth in the International Mechanical Code, Section 510.2, or if other hazardous vapors may be emitted through the duct system.

- I.4.4.1 It is recommended that base cabinets below chemical fume hoods be of standard construction or be equipped to store acids or bases. The storage of flammable chemicals below chemical fume hoods is not recommended; however, if it is requested by the user, it is recommended that these cabinets not be vented in concurrence with the National Fire Protection Association.
- I.4.4.2 All new chemical fume hoods shall be equipped with an indicating, monitoring device which signals a local audible alarm should the average face velocity drop below 60 feet per minute of existing fume hoods, or 20% below the accepted face velocity for new fume hoods (commissioned per ANSI/ASHRAE 110)
- I.4.4.3 The noise level at the face of the fume hood should not exceed 55 dBA.
- I.4.4.4 All chemical fume hoods shall have a documented certification post installation and prior to initial use, which verifies the appropriate average face velocity. Initial certification and associated documentation should be the responsibility of the installer. The monitor must be calibrated by the installer prior to initial use.
- I.4.4.5 Combination sashes are not recommended.

I.5.5 Point of Use Exhaust Systems

- I.5.5.1 Points of use exhaust systems such as flexible duct or “snorkel” tubes shall be installed according to manufacturers’ recommendations. Air flow volumes must be adequate to create a face velocity near the point of vent placement that effectively captures gas or vapor emissions. When manufacturer specifications are unavailable, the minimum face velocity is typically in the range of 60 to 100 feet per minute, one foot from the emission source. Higher or lower face velocities (air volumes) may permit effective capture depending on the distance from the exhaust tube and the direction and rate of the emission release.

I.5.6 Biological Safety Cabinets

- I.5.6.1 HEPA-filtered air from TYPE A2 biological safety cabinets can be re-circulated into the laboratory in BSL-1 and BSL-2 labs provided volatile chemicals will not be used in the biological safety cabinet.
- I.5.6.2 For certain applications, it may be recommended that the biological safety cabinet be equipped with an indirect or canopy connection exhausted from the room. Consult with EH&S to determine the appropriate class and type of biological safety cabinet.
- I.5.6.3 In special instances the biological safety cabinet may possess a hard ducted connection to exhaust volatile chemicals from the biological safety cabinet. Consult with EH&S to determine the appropriate class and type of biological safety cabinet.

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- I.5.6.4 Piped gas and piped air are not recommended within biological safety cabinets. Should the User request piped gas to the biological safety cabinet, approval from the EH&S is required prior to installation. If approved, the gas line shall be equipped with an emergency shut-off valve exterior to the biological safety cabinet but accessible to the biological safety cabinet user.
- I.5.6.5 Any other utilities supplied to the biological safety cabinet shall be installed under the biological safety cabinet.
- I.5.6.6 Biological safety cabinets shall not be installed as an integral part of the lab's air supply and exhaust system in such a manner that fluctuations of the room supply and exhaust cause the biological safety cabinet to operate outside design parameters for proper containment.
- I.5.6.7 All biological safety cabinets shall be installed and tested in accordance with National Science Foundation (NSF) Standard 49.
- I.5.6.8 All biological safety cabinets shall be certified according to NSF Standard 49 by an accredited biological safety cabinet technician post installation and prior to initial operation by the User. Additional specifications regarding biological safety cabinets are available from Environmental Health and Safety

I.6 Gas Service

- I.6.1 Gas service provided to the laboratory shall be commissioned for the necessary purity and flow rate prior to operation.
- I.6.2 All laboratories shall be provided with adequate securing devices for all empty and full compressed gas cylinders. These securing devices may be a strap, chain or other tether secured to non-mobile equipment or wall surface. A User-provided approved base is also acceptable.
- I.6.3 All laboratories using Health Hazard 3 and/or 4 gases shall be provided with approved gas cabinets. Exceptions can be made for storage and use of small lecture cylinders within certified chemical fume hoods. A maximum quantity of H3 or H4 gas per lab shall be based on the International Fire Code, Chapter 27 "Hazardous materials – General Provisions".
Gas cabinets shall be:
 - I.6.3.1 Constructed of not less than 12 gauge (2.5 mm or 0.097 in.) steel, coated to prevent corrosion and provided with a self-closing and self-latching cylinder access door;
 - I.6.3.2 Provided with a noncombustible safety window (6.4 mm or 0.25 in. wire-reinforced safety glass or equal) that allows viewing of equipment controls and provided with self-closing access port(s) or windows of sufficient size that allow hand access to equipment controls;
 - I.6.3.3 Provided with an approved automatic sprinkler;

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- I.6.3.4 Provided with makeup air inlets that allow air circulation throughout the cabinet when the access port(s) or windows are closed;
- I.6.3.5 Provided with exhaust ventilation that ensures the cabinet is at negative pressure in relation to the surrounding area and an average velocity of air flow at the face of open access ports or windows of 200 fpm (1.02 m/s) with a minimum of 150 fpm (0.75 m/s) at any measurement point.
- I.6.3.6 Provided with gas detection and/or ventilation monitoring to signal both an audible and visual alarm in the event of gas leakage and/or drop in velocity below the limits outlined above.
- I.6.4 For information on storage and use requirements for pyrophoric and/or flammable gases, please refer to the University of Pittsburgh Safety Manual issued by EH&S.

I.7 Lab Equipment

- I.7.1 Refrigerators shall be labeled to indicate if it is safe for storage of flammable liquids, or to indicate the presence of biohazards or/and radioactive materials.
 - I.7.1.1 Refrigerators should not be modified to accommodate storage of flammable materials.
 - I.7.1.2 In most instances, explosion-proof refrigerators are not necessary in research applications. Refrigerators equipped for flammable material storage are more likely for temperature sensitive User materials.
- I.7.2 EH&S and applicable codes do not require specially fabricated cabinets for acid storage. If requested by the User due to acid volumes, such cabinets are available and endorsed.
- I.7.3 First aid kits are not required or recommended within labs. Designers should avoid first aid kits on equipment lists.

I.8. Materials Handling

I.8.1 Loading Docks:

Building loading docks serving laboratory facilities shall have sufficient room to maneuver pallets and other material safely and a CAMPUS phone shall be placed near the loading area.

I.8.2 Chemical Storage Rooms:

Rooms designed to store corrosive chemicals shall be properly ventilated and shall have non-pervious, one piece chemical resistant floor coverings with covings to the wall and also chemical resistant wall surfaces.

I.8.3 Compressed gas cylinders Storage:

- I.8.3.1 Gas cylinders shall be stored in a well ventilated, dry location, at least 20 feet from highly combustible materials. Such enclosures shall serve no other purpose, shall

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operate at negative pressure in relation to the surrounding area, and shall have self-closing doors that are constructed of at least 12 gauge steel. In certain applications, sensors connected to alarms that notify occupants of a hazardous condition may be required. Such detection and alarm systems shall be considered.

- I.8.3.2 Emergency power shall be provided for exhaust ventilation, gas-detection systems, emergency alarm systems, and temperature control systems.
 - I.8.3.3 Storage areas shall be secured against unauthorized entry.
 - I.8.3.4 Compressed gas cylinders shall be protected from external heat sources such as flame impingement, intense radiant heat, electric arc, or high temperature steam lines
 - I.8.3.5 Adequate space shall be made available for the segregation of gases by hazard class. Flammable gases shall not be stored with oxidizing agents.
 - I.8.3.6 Liquefied fuel-gas cylinders shall be stored in an upright position so that the safety relief device is in direct contact with the with the vapor space in the cylinder at all times.
 - I.8.3.7 The heating of flammable gas storage areas shall be indirect heat, such as by air, steam, hot water, etc.
 - I.8.3.8 Restraints shall be included for the storage of all compressed gas cylinders whether empty or full.
- I.8.4 Cryogenic Liquid Tanks:**
- I.8.4.1 Cryogenic liquid tanks shall be placed in such a manner that their controls could not accidentally be manipulated and such that they may be secured to prevent unauthorized access. The position of valves and switches for emergency shutdowns shall be accessible to authorized personnel only and clearly labeled.
 - I.8.4.2 Critical vent areas should be covered, or pointed down (i.e. Dewar necks and pressure reliefs)
 - I.8.4.3 Cryogenic liquid tanks should be placed away from below grade areas where dense vapors may collect and away from glass doors or windows
 - I.8.4.4 Un-insulated pipes or vessels shall be positioned and/or identified to prevent inadvertent contact with an unprotected part of the body.

I.8.5 Storage of Flammable and Combustible Liquids

Note: In the following section all referenced 'Classes' and 'liquids' are flammable liquids and flammability classifications as applied by the National Fire Protection Association.

I.8.5.1 An approved flammable liquids storage cabinet is required when:

I.8.5.1.1 The aggregate volume of Class I and Class II liquids in an individual fire area not in safety cans exceeds 10 gallons.

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- I.8.5.1.2 The aggregate volume of Class I and Class II liquids in an individual fire area in safety cans exceeds 25 gallons.
- I.8.5.1.3 The aggregate volume of Class IIIA liquids exceeds 60 gallons
- I.8.5.1.4 The aggregate volume of Class IIIB liquids exceeds 220 gallons. This applies only to mechanical areas containing hydraulic oils, lubricating oils, etc.
- I.8.5.2 When a cabinet is provided, it shall be used for the storage of a flammable and combustible materials not in immediate use.
- I.8.5.3 Flammable Material Storage Cabinets must be:
 - I.8.5.3.1 UL/FM approved and marked in conspicuous lettering:

“FLAMMABLE – KEEP FIRE AWAY”
 - I.8.5.3.2 Limited so that the maximum quantity of Class IA liquids is 30 gallons within the cabinet.
 - I.8.5.3.3 Un-vented. If venting is required or requested, EH&S must be contacted for a specific evaluation and guidelines.
 - I.8.5.3.4 Equipped with self-closing and self-latching doors if purchased after 2005. If the cabinets were purchased prior to 2005 and came equipped with self-latching door mechanisms, it is recommended that this safety device be maintained as operational.
- I.8.5.4 A maximum of three (3) flammable material storage cabinets shall be located within a single fire area.
- I.8.5.5 Approved Flammable Liquid Storage Rooms are constructed and utilized in compliance with the following guidelines:
 - I.8.5.5.1 For all containers of Class I and Class II liquids with a capacity greater than 5 gallons.
 - I.8.5.5.2 For any quantity of Class III liquids exceeding 330 gallons (the maximum capacity of 3 flammable liquids cabinets).
 - I.8.5.5.3 Walls, floors and ceilings must be constructed of non-combustible materials and have a fire-resistive rating of not less than one hour. In many cases, a 2 hour rating may be necessary.
 - I.8.5.5.4 Doorways must be provided with non-combustible liquid-tight raised sills or ramps to contain spilled material.
 - I.8.5.5.5 Approved fire doors must be provided, and kept closed and latched at all times (or arranged to close automatically in case of fire).

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- I.8.5.5.6 The entrance to the room should be labeled in accordance with NFPA 704 – Identification of the Hazards of Materials for Emergency Response Consult EH&S.
- I.8.5.5.7 Proper ventilation must be provided. Storage and other materials should not obstruct the exhaust ventilation.
- I.8.5.5.8 Heating is restricted to low pressure steam or hot water.
- I.8.5.5.9 Lighting and electrical service must be properly rated for the materials being stored and/or dispensed in the room. Electrical wiring and utilization equipment for Class I liquid storage shall be Class I, Division 2, and electrical wiring and utilization equipment in inside storage rooms used for the storage of Class II and Class III liquids shall be suitable for general purpose.
- I.8.5.5.10 The room should be kept free of compressed gasses and all combustible materials such as empty boxes, Styrofoam shipping containers, plastic supplies and materials, and trash containers.
- I.8.5.5.11 As applicable, automatic detection and suppression systems are required in new or renovated rooms. Depending on stored quantities, a secondary supplemental fire suppression system may be needed.
- I.8.5.5.12 A carbon dioxide (CO₂) type fire extinguisher must be provided within 10 ft. of the door entrance external to a flammable liquids storage room.

I.8.5.6 Dispensing of Class I liquids

- I.8.5.6.1 If dispensing of Class I liquids to or from containers less than or equal to 5 gallons (20 L) in capacity is requested by the user, validate the availability of a certified chemical fume hood or a flammable liquid storage room constructed and equipped to meet the International Fire Code requirements for dispensing Class I flammable liquids.
- I.8.5.6.2 If dispensing of Class I liquids to or from containers greater than 5 gallons (20 L) in capacity is requested by the User, a flammable liquid storage room constructed and equipped to meet the International Fire Code requirements for dispensing Class I flammable liquids shall be provided. The Professionals and the PM shall consult with EH&S for additional interpretation.

I.8.5.7 Rooms Requiring Fire-Rated Enclosure

- I.8.5.7.1 Flammable Liquid Storage Rooms shall be constructed in compliance with the current International Fire Code and the following guidelines:
 - I.8.5.7.1.1 Walls, floors and ceilings shall be constructed of non-combustible materials and have a fire-resistive rating of not less than one hour. For rooms utilized to dispense containers of 5 gallons or more, a minimum 2 hour rating is necessary.

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- I.8.5.7.1.2 Doorways shall be provided with non-combustible liquid-tight raised sills or ramps to contain the contents of spilled material from the largest anticipated container size.
- I.8.5.7.1.3 Approved fire doors shall be provided with self-closing devices and positive latching mechanisms (or be arranged to close and latch automatically in case of fire).
- I.8.5.7.1.4 The entrance to the room shall be labeled in accordance with NFPA 704 – Identification of the Hazards of Materials for Emergency Response.
- I.8.5.7.1.5 Proper ventilation shall be provided. Storage and other materials should not obstruct the exhaust ventilation.
- I.8.5.7.1.6 Heating is restricted to low pressure steam or hot water systems.
- I.8.5.7.1.7 Lighting and electrical service shall be properly rated for the materials being stored and/or dispensed in the room. Electrical wiring and utilization equipment for Class I liquid storage shall be Class I, Division 2, and electrical wiring and utilization equipment in inside storage rooms used for the storage of Class II and Class III liquids shall be suitable for general purpose.
- I.8.5.7.1.8 Compressed gasses and combustible materials such as empty boxes, Styrofoam shipping containers, plastic supplies and materials, and trash containers shall not be designed for storage in flammable liquid storage rooms.
- I.8.5.7.1.9 Automatic detection and suppression systems are required. Depending on stored quantities, a secondary supplemental fire suppression system may be needed. A secondary supplemental fire suppression system is required in dispensing rooms.
- I.8.5.7.1.10 A carbon dioxide (CO₂) type fire extinguisher shall be provided within 10 ft. of the door entrance external to the flammable liquids storage room.

J. Considerations for Radioactive Materials Use

J.1 General

The design of laboratories involving the use of radioactive materials requires the participation of the University of Pittsburgh's Radiation Safety Office (RSO). It is the PM's responsibility to bring into the design process an RSO representative from the very early stages of design. Based on the quantity and type of radioactive materials to be used in the laboratory, the RSO will determine the level of safety required and specify any additional laboratory design requirements accordingly.

J.1.1 Two issues shall be considered in the design of these laboratories:

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- 1) Protection of the laboratory worker and
 - 2) Protection of persons outside the facility.
- J.1.2 To avoid unnecessary exposure, the amount of movement of radioactive material shall be minimized inside and outside the laboratory. This is achieved by locating the areas where the radioactive materials will be used in as close proximity to each other as feasible.
- J.1.3 All surfaces of the radioactive laboratory and radioactive materials' storage areas shall be finished with materials that can be easily decontaminated.
- J.1.4 Coat hooks shall be provided within the laboratory as close as possible to the exit, so that laboratory personnel can remove potentially contaminated laboratory clothing prior to leaving the facility.
- J.1.5 Desks and study facilities should not be located in areas where radioactive materials are to be handled.

J.2 Security:

- J.2.1 Areas where radioactive materials are used or stored shall have restricted access. See 3.3 for security locks' requirements.
- J.2.2 Access to areas where radioactive materials are stored (refrigerators, cabinets, etc.) shall be restricted by locks or other security means.
- J.2.3 Rooms designed to contain a gamma irradiator are subject to increased security controls regarding access and security response.

J.3 Storage of radioactive materials:

- J.3.1 Although small amounts of radioactive wastes may be stored in the laboratory, provisions shall be made for the accumulated waste from multiple laboratories, as applicable. This would be a designated storage area, separate from the laboratory and from other waste storage areas. Radioactive wastes cannot be co-mingled with chemical, biological or household waste.
- J.3.2 Appropriate shielding shall be provided for radioactive storage locations if required by the RSO. If shielding is required, radiation shielding shall be approved by the RSO.

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Section P-3

A. Applicability

- A.1 Division P-1, Sections A and B, "Applicability of the Laboratory Design Standards" is hereby made part of this section by reference.
- A.2 The Professionals are hereby informed that the University of Pittsburgh and the Association for Assessment and Accreditation of Laboratory Animal Care International (AAALAC) **must** comply with the physical requirements set forth in the "Guide for the Care and Use of Laboratory Animals" promulgated by the National Research Council in 1996. It is the Professional's responsibility to follow these guidelines in the design, construction and renovation of University's research animal spaces.
- A.3 In addition, the University's minimum Standards and Procedures described in this section apply to the design, construction and renovation of research animal spaces.
- A.4 For requirements that are mandatory in these Standards, requests for variances shall be submitted in writing to the Project Manager (PM), to be forwarded to the University Division of Laboratory Animal Resources (DLAR) for review and approval.

B. Corridors

- B.1 Corridors shall be wide enough to facilitate the movement of personnel and equipment. Corridors 6-8 ft wide can accommodate the needs of most facilities.
- B.2 Floor-wall junctions shall be designed to facilitate cleaning.
- B.3 In corridors leading to dog and swine housing facilities, cage-washing facilities and other high-noise areas, double-door entry or other noise traps should be considered.
- B.4 Water lines, drainpipes, electric-service connections and other utilities shall be accessible through access panels or chases in corridors outside the animal rooms. Fire alarms, fire extinguishers and telephones shall be recessed or installed high enough to prevent damage from the movement of large equipment.

C. Animal Room Doors

For safety, doors should open into animal rooms; however, if it is necessary that they open toward a corridor, recessed vestibules should be provided. Doors that open inward are required for animal holding rooms and animal procedure rooms at bio-safety levels 2 and 3. Doors with viewing windows are preferable for safety and other reasons.

- C.1 Doors shall be large enough (approximately 42"x 84") to allow the easy passage of racks racks and equipment.
- C.2 Self-closing doors equipped with recessed or shielded handles, threshold sweeps and and kick-plates are preferred.

D. Floors

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- D.1 Floors shall be moisture-resistant, nonabsorbent, impact-resistant and relatively smooth, although textured surfaces might be required in some high-moisture areas and for some species (such as farm animals).
- D.2 Floors shall be resistant to the action of urine and other biologic materials and to the adverse effects of hot water and cleaning agents.
- D.3 Depending on their use, floors should be monolithic or have a minimal number of joints.
- D.4 If the use of the room requires that the floor be waterproof, the provision of a waterproofing membrane under the floor shall be considered. The Professional shall consult with the User to determine the need for a waterproof floor (except as noted in E.2 below).

E. Floor Drainage

- E.1 Where floor drains are used, the floors shall be sloped as required to allow for rapid removal of water and drying of surfaces. Floor drains are not essential in all animal rooms, particularly those housing rodents. Also, drains are not necessarily required on all rooms where a waterproof floor is installed.
- E.2 Rooms that require a floor drain shall also have a waterproof floor.

F. Walls

- F.1 Walls shall be smooth, moisture-resistant, nonabsorbent and resistant to damage from impact. They shall be free of cracks, of unsealed utility penetrations and of imperfect junctions with doors, ceilings, floors and corners.
- F.2 Surface materials shall be capable of withstanding cleaning with detergents and disinfectants and the impact of water under high pressure. Curbs, guardrails and/or bumpers shall be provided to protect walls and corners from damage.
- F.3 If the use of the room requires that the walls be waterproof, the provision of a waterproofing membrane under the finished wall surface or other means of waterproofing the walls shall be considered. The Professional shall consult with the User to determine the need for waterproof walls.

G. Ceilings


- G.1 Ceilings shall be smooth, moisture-resistant and free of imperfect junctions. Surface materials shall be capable of withstanding cleaning with detergents and disinfectants. Exposed plumbing, ductwork and light fixtures are not acceptable unless the surfaces can be readily cleaned. Ceilings of plaster or fire-proof plasterboard shall be sealed and finished with a washable paint.
- G.2 Generally, suspended ceilings are not acceptable unless they are fabricated of impervious materials with a minimum of seams and free of gaps. In certain cases, "security-type" suspended ceilings may be required to prevent the ingress of animals into the ceiling cavity.

H. Storage Areas

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- H.1 Adequate space shall be provided for storage of equipment, supplies, food, bedding and refuse. Corridors used for passage of personnel or equipment shall not be used as storage areas.
- H.2 Bedding and food shall be stored in a separate area, in which materials that pose a risk of contamination from toxic or hazardous substances are not stored. Refuse storage areas shall be separated from other storage areas.
- H.3 If required by program needs, refrigerated storage, separated from other cold storage shall be provided for carcass storage and animal-tissue waste; this storage area shall be kept below 7 degree C (44.6 degrees F) to reduce putrefaction of wastes and animal carcasses.

I. Heating, Ventilating and Air Conditioning (HVAC)

- I.1 Of particular concern in the commissioning and final approval of newly constructed or renovated research animal spaces are heating, ventilation and air conditioning (HVAC) criteria. HVAC systems shall be designed for reliability, ease of maintenance and energy conservation.
Air from animal housing and animal support spaces shall be single pass air and cannot be re-circulated. 
- I.2 Design professionals should consider split systems to prevent total system shutdown. Final redundancy factors for a specific facility will be developed in consultation with the University's DLAR and Department of Environmental Health and Safety (EH&S) for each system.
- I.3 Each HVAC system shall be capable of maintaining dry- bulb temperatures to plus or minus two degrees Fahrenheit of an established set point. Final set point will be provided by DLAR. The established set point and ranges of available set points shall be consistent with species specifications, but is typically 72 plus or minus 4 degrees Fahrenheit.
- I.4 Recommended Dry-Bulb temperatures for common laboratory animals are as follows:

Animal	Dry-Bulb Temperature	
	C	F
Mouse, rat, hamster, gerbil guinea pig	18-26	64-69
Rabbit	16-22	61-72
Cat, dog, nonhuman primate	18-29	64-84
Farm animals and poultry	16-27	61-81

The relative humidity shall be maintained within a pre-determined range identified for the species housed. Typically 40-45% with a +/- 5% variance is used. Humidity must not exceed a range of 30 – 70 percent at any time throughout the year for any animal holding room. Thermostatic and humidification controls shall be provided for each research animal room.

In general, the following room occupancies are designed under negative pressure relative to the corridor: quarantine, housing of animals exposed to hazardous materials (such as BSL-2 agents or chemical hazards), procedure rooms, and housing of non-human primates. In general, the following

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room occupancies are designed under slight positive pressure relative to adjacent corridors: surgery, clean equipment storage, and transgenic animal housing. Directional air flow for rooms designated as pathogen free animal housing will be pre-determined by DLAR in conjunction with the Users during the design process.

All of the spaces referenced in 9.8 above, shall be designed with adequate ventilation rates typically between 12 to 15 air changes per hour. In rare instances, 10 air changes per hour can be accepted for specified areas. The Professional shall review this issue with the Project Manager (PM) and the Division of Laboratory Animal Resources (DLAR) and obtain approval before reducing the number of air changes below 12 per hour.

J. Power and Lighting

- J.1 In the event of power failure an alternative or emergency power supply shall be available to maintain critical services (i.e. the HVAC system) or support functions (i.e. freezers, ventilated racks, isolators, etc.), in animal rooms, operating suites and other essential areas.
- J.2 Light fixtures, timers, switches and outlets shall be properly sealed to prevent vermin and pest entry. The need for the provision of a time-controlled lighting system shall be reviewed with the Users, to ensure a uniform diurnal lighting cycle.
- J.3 Light bulbs or fixtures shall be equipped with protective covers to ensure the safety of the animals and personnel.
- J.4 Moisture-resistant switches and outlets and ground-fault interrupters shall be used in areas with high water use, such as cage-washing areas, certain animal holding rooms where wash-downs are common and aquarium-maintenance areas.

K. Additional Approval Process for New or Renovated Animal Facilities

K.1 Design Phase

Besides the approvals described in the Professional Design Manual for regular projects, early during the design phase of the animal facility project, the PM will bring into the design process a representative from the DLAR, as needed, to provide specific recommendations and information, as well as criteria to be followed. Criteria shall be obtained from approved codes and recognized industry or national standards. The PM will also provide the DLAR with the opportunity to attend design meetings as needed and to review progress documents.

During the project design development phase, the Professional shall submit an airflow diagram to the PM, to be forwarded to EH&S and the DLAR for approval. The diagram needs to include pressure flow patterns within animal areas, as well as their relationship to adjoining corridors and areas.

If possible, computational flow dynamics should be employed to evaluate air flow patterns within animal rooms design and for caging systems planned, so as to avoid drafts and "dead air" spaces that could adversely affect animal health.

K.2. Construction Phase

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- K.2.1 Prior to the occupancy of a new or renovated area for animal research, approval is required by the University's Institutional Animal Care and Use Committee (IACUC). IACUC is the University Committee in charge of approving all animal facilities renovations or new construction prior to occupancy.
- K.2.2 The PM will interact with the IACUC representative as established in the Facilities Management Project Management Manual dated January 2007 and as required to obtain timely approval of the animal facility prior to occupancy. The PM is responsible for gathering and forwarding to the Committee representative all the information required in the IACUC Required Information for New Construction or Renovations form included here as Exhibit 1. Some of this information will be provided by the Commissioning Agent.
- K.2.3 The Professional shall also provide required information to the PM in a timely manner and shall work with him/her to obtain IACUC approval prior to building occupancy.
- K.2.4 The Professional shall incorporate the following paragraph in the project specifications: "The Contractor shall ensure adequate pest control during new construction, including the prevention of infiltration by native rodents and flying insects".

EXHIBIT 1

**IACUC REQUIRED INFORMATION FOR NEW
CONSTRUCTION OR RENOVATIONS**

A. GENERAL INFORMATION:

BUILDING NAME	APPROX. SQ. FT. OF ANIMAL CARE AND USE SPACE	APPROX. SQ. FT. OF SUPPORT SPACE	SPECIES HOUSED	SITE SUPERVISOR

Date of Completion: _____

**If Renovation,
Describe:** _____

Has the project been approved by the Department of Environmental Health and Safety, Office of Radiation Safety, and Attending Veterinarian as described in "Guidelines for Quality Control of Major Renovation and/or New Construction of Research and Teaching Laboratory Space at the University of Pittsburgh" Y/N
If no, please explain

B. HVAC SYSTEM SPECIFICS:

Summarize the heating, ventilation and air conditioning (HVAC) information for each animal room/facility in the HVAC Data Table I and II.

Who performed the ventilation measurements: _____

When were measurements taken: _____

Method used (hot wire anemometer, velometer, etc.) _____

Provide a diagram of the ventilation system supply and exhaust lines. Diagram should show: 1) service to each room, 2) if any supply or exhaust lines come from a common trunk line, 3) if exhaust lines are direct to roof or go to filter or mixing chamber,.

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Provide information on supply or exhaust fan system redundancy:

Provide information on heating system (electric, gas, steam, other) and any system redundancy:

Provide information on the humidification system:

How is Temperature and Humidity monitored: _____

How are T/H over range and under range events reported:

How is pressure gradient between rooms/hallway monitored:

Describe any special ventilations systems (i.e. Bio-containment cubicles, anesthetic gas scavenger systems, chemical fume hoods).

ROOM LOCATION	TYPE (HOOD, DUCT, ETC.)	DESIGN CRITERIA (i.e. 100 fpm face velocity)	EFFICACY MONITORING (annual face velocity, etc.)

B. Illumination Specifics:

Describe the lighting system in Table III.

C. Noise:

Describe the facility design features and other methods used to control, reduce, or prevent excessive noise in the animal facility.

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D. Construction:

Describe the finishes throughout the animal facility for floors, walls, ceilings, and doors.

Floors: _____

Walls: _____

Ceilings: _____

Doors: _____

Describe the general arrangement of the animal facilities (conventional, clean/dirty corridor, etc.)

Note specialized types of available animal housing spaces such as barrier or hazard containment animal cubicles or facilities designed specifically to house certain species of animals such as pens for dogs, pigs, sheep, NHP, etc.

Note if emergency power is provided for the animal facility and if so, what electrical services it maintains in the event of primary power failure.

Describe storage facilities for cages, equipment, supplies, and flammable or hazardous agents and materials.

Describe for each cage sanitation area its location, the traffic flow patterns (soiled to clean or in and out) within the facility, and kinds of equipment (tunnel washer, bottle washer, rack washer, etc.). If cage sanitation is done elsewhere, state location and how cages are transported to the site.

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F. Operation

Water Systems:

If using other than direct city water, describe water source and treatment methods. _____

Sewer System:

If using other than direct city sewer hook up, describe sewage systems. _____

Transportation:

Describe how animals or caging systems will be received at this location:

Describe circumstances in which animals or caging equipment are transported in common use corridors or elevators having the potential to come in contact with individuals not associated with the animal care and use program.

Security:

Describe procedures for maintaining security in animal housing areas such as perimeter fencing, gates, entry way access control, cameras, or night patrols and provide the department with responsibility.

Describe any fire protection systems.

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Section P-4: Design of BSL3 Containment Facilities

Division P-1, Sections A and B, "Applicability of the Laboratory Design Standards" is hereby made part of this Section by reference.

A. Physical Construction and Layout

A.1. Isolation of the BSL3 Containment

A.1.1. Location: Consideration shall be given to the location of the BSL3 containment within the building to minimize risk of exposure:

A.1.1.1. Locate away from exterior building envelope walls

A.1.1.2. Locate away from high-traffic public areas, such as cafeterias, emergency rooms, etc.

A.1.1.3. Locate adjacent to or nearby mechanical rooms to minimize lengths of containment ducts.

A.1.2. Separation: Separate BSL3 Containment from common areas that are open to unrestricted traffic flow within the building and corridors available to normal traffic flow of laboratory personnel.

A.1.3 Restricted Access Via Airlock: Restrict access to the BSL3 Containment to unauthorized personnel by separating from public by a series of two separate, self-closing, lockable doors (recommend automated controlled access system, e.g. key card or equivalent) that are interlocked with manual emergency overrides to prevent both doors from being open at the same time.

A.1.4. Consideration for Access by Maintenance and Auxiliary Personnel: All access to critical mechanical equipment (ventilation ducts, fans, piping, compressor monitors or gas supplies, etc.) must be provided outside of the BSL3 Containment. If access to critical mechanical equipment must be maintained inside the BSL3 Containment, access panels shall be supplied inside the laboratory to allow access to such mechanical equipment and must be appropriately labeled for the purpose. The access panel must be hinged (piano- type hinge) and gasketed with gas-tight gaskets to ensure an appropriate seal for both containment and decontamination procedures.

A.2. Physical Construction of BSL3 Containment: The BSL3 Containment shall be constructed so that it can be sealed to permit gas decontamination and fumigation (e.g., formaldehyde gas) and to effectively contain aerosols and airborne organisms within BSL3 Containment. No compromise of the integrity of the containment of the BSL3 laboratory is allowed.

A.2.1. Walls:

For BSL3: To prevent release of agent into any adjacent spaces, walls of appropriate construction and finish (to facilitate cleaning and withstand routine chemical disinfection) shall be provided, that extend the FULL height from finished floor to the floor slab above, The facility shall be designed to essentially be leak-free when negatively pressurized to 0.5 in WG and checked with smoke and soap solution. **For ABSL3:** Non-load-bearing masonry, concrete or equivalent is recommended and above requirements for BSL3 must also be met. **For ABSL3 rooms** in which the walls will serve as a primary biocontainment barrier, the walls shall be sufficient to withstand pressure decay test to 2"

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WG with integral cove base to floor and must extend the FULL height from finished floor to the floor slab above.

NOTE: *The room integrity test requirements for facility commissioning will vary depending on the intended use of the facility. These test criteria should be decided upon by EH&S prior to or during the initial phase of facility design. The rooms shall be designed and constructed to allow non-destructive pressurization testing of the spaces.*

A.2.2. Ceilings: shall be reinforced steel frame and gypsum, filler primer and paint finish to prevent release of agent into any adjacent spaces.

A.2.3. Floors: shall be monolithic and slip-resistant. Continuity of seal to be maintained between the floor and wall (a continuous cove floor finish up the wall is required).

A.2.4. Joints and Seams: shall be permanently sealed to prevent passage of air and liquid. All joints between fixed cabinetry and the floor or wall must be smooth-coved and sealed to ensure maximum cleanability.

A.2.5. Penetrations: shall be sealed with a smooth finish or nonshrinking sealant at the BSL3 Containment barrier (or capable of being sealed) to facilitate decontamination and cleaning and to assure isolation of the BSL3 Containment (e.g., light fixtures, fire sprinklers, electrical and telecommunication conduits, water and utility lines, HVAC ductwork, utility access panels, condensate return lines, air supply lines, etc.)

A.2.6. Interior Surfaces, Coatings and Finishes: shall be smooth, continuous, and impermeable to liquids, detergents, disinfectants, and decontamination gases normally used in the laboratory. Scratch, stain, impact, and heat resistant are preferred.

A.2.7. Windows: Windows in BSL3 Containment perimeter are prohibited, with the following exception: observation windows that are inoperable and sealed in the shut position, located on an internal building wall that are made of tempered, break resistant glass and have sloped interior windowsills.

A.2.8. Airlock Doors: Shall be self-closing, lockable and shall provide restricted access (via keycard system--preferred), adequate size to allow passage of all anticipated equipment, made of solid finish construction, and interlocked with manual emergency overrides to prevent both doors from being open at the same time.

A.3. Casework and Furniture in the BSL3 Containment


A.3.1. Bench Tops: shall be impervious to water and resistant to moderate heat, organic solvents, acids, alkalis and chemicals used to decontaminate the work surfaces and equipment; capable of containing spillage of materials (e.g. with marine edges, drip stops, and backsplashes that are installed tight to wall and sealed at wall-bench junction); and continuous (i.e. with no open seams).

A.3.2. Casework and Fixed Lab Furniture: shall be designed and installed in such a way as to facilitate cleaning and decontamination of all exposed and adjacent surfaces.


A.3.3. Movable Lab Furniture: Chairs and other furniture in BSL3 Containment should be covered with material that can be easily decontaminated and prevents the absorption of liquids.

A.4. Personal Hygiene, Safety and Waste Disposal Facilities in the BSL3 Containment

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- A.4.1. Change Room and Shower Facility:** A shower facility should be provided for exit from the BSL3 Containment area and is required for ABSL3 facilities. Provide clothing change area to separate personal clothing from laboratory clothing dedicated to that zone. Provide storage space (lockers preferred) within the clothing change area for personal clothing.
- A.4.2. Laundry Hamper:** Adjacent to exit door on “dirty side” of BSL3 Containment, provide space for laundry hamper for used/soiled laboratory clothing to be autoclaved prior to laundering.
- A.4.3. Hand Washing Facilities:** A tempered-water, hands-free or automatically operated hand washing facility shall be provided near the exit door of each primary BSL3 Containment module. Soap dispensers and paper towel dispensers shall be immediately accessible to the hand-washing sink so paper towels may be obtained via hands free method. 
- A.4.4. Emergency Eyewash:** Emergency eyewash facilities shall be provided in the BSL3 Containment in accordance with laboratory activities and applicable regulations (i.e., ANSI Z358.1).
- A.4.5. Emergency Shower:** Every effort should be made to limit the quantities of hazardous chemicals within the laboratory. When this is not possible, emergency shower equipment shall be provided in the BSL3 Containment in accordance with laboratory activities and applicable regulations (i.e. ANSI Z358.1.) Consider floor drain issue on a case-by-case basis.
- A.4.6. Biowaste Storage:** Provide space for support stands for biological waste bags. If necessary due to volume or other need, provide refrigerated space for lockable, closed storage for biological waste.

B. Laboratory Services and Utilities

B.1. Lighting and Illumination: Illumination shall be adequate for all activities, avoiding reflections and glare that could impede vision; 70 ft.-candles of light at work surface level (metric) minimum maintained at work surface is recommended. All fixtures shall be vapor-tight, moisture-proof, enclosed, and/or gasketed light fixtures that are surface mounted and installed flush against the ceiling to prevent dust accumulation and minimize penetrations into the room. If possible, fluorescent light ballasts and starters should be located outside BSL3 containment area. 

B.2. Gases: Compressed gas cylinders supplying carbon dioxide, nitrogen and other gases shall be stored outside the BSL3 Containment, and manifold piping shall be used to provide the gases inside the BSL3 Containment. Air and gas lines shall be protected by in-line HEPA filters and backflow prevention.

B.3. Electrical System

- B.3.1. Emergency Backup Power:** Provide emergency backup power as required for life safety systems as well as essential systems and equipment in the BSL3 Containment, such as certain lighting, HVAC systems, Biosafety Cabinets, and security systems.

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B.3.2. Power Distribution Panels: Separate power and lighting distribution panels shall be provided for the BSL3 Containment, located outside BSL3 Containment.

B.3.3. Electrical Conduit and Wiring: All outlets, fixtures, junction boxes and conduit in BSL3 shall be surface mounted and installed per Section 1.2 to minimize penetrations.

B.3.4. Interlocks: The entryway airlocks, pass boxes, and double-door sterilizers of the BSL3 Containment shall be protected with electrical interlocks so that both doors cannot be opened simultaneously.

B.4. Security Systems for BSL3 Containment: Building security systems integrated with laboratory safety and monitoring systems (e.g., cardkey access) shall be provided as needed.

B.5. Communications Systems: BSL3 Containment shall be equipped with a voice communication system between containment zone and support area (e.g., telephone, intercom, etc.). In addition, a communication system shall be provided for electronic transfer of information and data from laboratory area to outside laboratory perimeter (e.g. fax machine, computer, etc.). Consider a clearly marked "panic button" to activate alarm under emergency conditions and summon help.

B.6. Plumbing System

B.6.1. Backflow Prevention: Provide supply and wastewater services with backflow prevention (i.e., in addition to premises isolation).

B.6.2. Piping: Piping shall be surface mounted per Section 1.2, clear of walls to allow access for maintenance and cleaning.

B.6.3. Water Supply Shut Off Valves: Water supply shut off valve shall be located outside of BSL3 Containment perimeter. In addition, it is also recommended that a water shut-off valve to BSL3 Containment be located inside the BSL3 Containment perimeter.

B.6.4. Drains:

B.6.4.1. Separation of Drains and Related Piping: Drains and associated piping from BSL3 Containment shall be separated from other laboratory areas (i.e. go directly to main collector for sanitary sewer and connected to an effluent sterilization system, if necessary) and void of potential cross-connections.

B.6.4.2. Floor Drains: Floor drains should not to be provided, except when essential. Consider temporary floor drain caps and/or devices to maintain seal and prevent drain traps from going "dry."

B.6.4.3. Cleanouts: All cleanout plugs for the drains in the BSL3 Containment shall be located within the BSL3 Containment.

B.6.4.4. Autoclave Chamber Condensate: must be located and drain within the BSL3 Containment, unless the autoclave is equipped with a condensate decontamination cycle prior to discharge.


B.6.5. Vent Lines: BSL3 Containment plumbing vent lines shall be equipped with HEPA filters and be independent of noncontainment plumbing vent lines.

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B.6.6. Waste Liquid Effluent (Bio-Waste) Sterilization System: Liquid effluent (bio-waste) sterilization system should be considered for BSL3 Containment. (Required for BSL3-Ag Containment.)

B.7. Vacuum System: Central building vacuum systems are not permitted to be extended into the BSL3 Containment because of problems associated with contamination of pipelines and exhaust air. Rather, individual vacuum pumps or a vacuum system dedicated to the BSL3 Containment, which are also properly protected with liquid disinfectant traps and HEPA filters, shall be provided.

B.8. Heating, Ventilation and Air Conditioning (HVAC) Systems

B.8.1. HVAC Control Systems: HVAC control system(s) shall be installed to prevent positive pressurization of the BSL3 Containment. The supply and exhaust fans shall be interlocked to prevent positive pressurization in the event of exhaust fan failure or exhaust isolation damper closure. This system must control airflow rate to the BSL3 Containment to remain reasonably constant for 24 hours per day. 

B.8.2. Monitoring and Alarms: Visual monitoring devices (gauges) and audible alarms that are audible inside and outside the BSL3 Containment shall be installed, to indicate and confirm that directional inward airflow is provided at the BSL3 Containment entry.

B.8.3. Single Pass Air/No Recirculation: The HVAC system shall be designed to utilize 100 % outside, single-pass air.

B.8.4. Directional Airflow: shall be inward to the BSL3 Containment and shall remain unchanged under all conditions (e.g., from areas of least potential hazard toward toward areas of greatest potential hazard and from less contaminated to more contaminated spaces).

B.8.5. Exhaust - Air Change Rates: The ventilation system shall exhaust air from BSL3 Containment at a minimum of 10 to 12 air changes per hour (ACH) for 24 hours per day.

B.8.6. Pressure Differential of BSL3 Containment: BSL3 Containment shall be kept negative with respect to adjacent corridors and laboratories.

2.8.6.1. Recommendations to create this infiltration include a 15 percent differential between exhaust and supply or sufficient exhaust to create an 0.05 inch water column differential between the laboratory and the access area.

B.8.7. Dedicated Air Exhaust:: A separate exhaust system shall be provided for BSL3 Containment areas for isolation purposes.

B.8.8. Dedicated Air Supply: A separate supply system should be provided for BSL3 Containment areas for isolation purposes.

B.8.9. Redundant Air Supply and Exhaust:: Fully redundant exhaust fans (in parallel) are required, while redundant supply fans are recommended.

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- B.8.10. HEPA-Filtered Exhaust::** HEPA filtration of exhaust is required; ducted exhaust shall be discharged through an accessible, redundant, HEPA filter. The redundant HEPA filters shall be provided in parallel, including appropriate bubble-tight isolation dampers to allow complete isolation of either filter for certification or gas decontamination while the other filter and exhaust system remain operational.
- B.8.11. HEPA-Filtered Supply:** HEPA filtration of supply is not required, but should be considered, especially if warranted by research activity or if the BSL3 Containment is served by the common building supply.
- B.8.12. HEPA Filters and Pre-Filters:** Each housing shall include HEPA filters with minimum particulate removal of 99.97% for particles of 0.3 μm . A monitoring device, such as a magnehelic gauge or equivalent electronic device must be provided to monitor pressure drop across the filters. Coarse pre-filters must also be provided and it is recommended to locate them at the containment room in a manner that facilitates change-out by lab personnel within containment for autoclave decontamination.
- B.8.13. HEPA Filter Housings:** HEPA filter exhaust housing and associated ductwork shall include sampling and injection ports to allow for appropriate leak testing in place (inlet test sections are recommended) and shall be equipped with bubble-tight isolation dampers and housings suitable for gas decontamination and testing. Consideration should be given to inlet test section Supply and Exhaust HEPA filter housings to be designed for structural stability (no structural change at applied pressure of 1000 Pa [4" wg]).
- B.8.14. Location of HVAC Equipment:** All HVAC equipment shall be located outside the BSL3 Containment envelope for ease of maintenance, testing, replacement of filters and other servicing.
- B.8.15. Ductwork:** Exhaust ductwork shall be sealed airtight, independent from other laboratory zones, accessible from outside the BSL3 containment zone, and under negative pressure until the air is discharged outside the building. Ductwork shall withstand 10% loss of pressure at 1000 Pa (4" wg) over a 30-minute period, including all joints and seams and shall be constructed of a material able to withstand routine chemical disinfection.
- B.8.16. Isolation Dampers:** Supply and exhaust ducts for BSL3 laboratories shall be supplied with 100% shut off dampers (gas-tight, bubble-tight) to ensure the capability of laboratory isolation during emergency situations as well as gas decontamination without compromising the rest of the building. The dampers shall automatically activate to prevent positive pressurization of the containment spaces (i.e., supply dampers close upon loss of exhaust) and must also reopen with appropriate sequence to avoid positive pressurization.
- B.8.17. Emergency Shutdown:** Provide manual control device that allows the shut down of supply and exhaust fans and closing of isolation dampers on supply and exhaust ducts to BSL3 Containment to fumigate room with disinfecting gas.
- B.8.18. Air Backflow Prevention:** Air supply and exhaust ducts penetrating the containment barrier shall be provided with backflow prevention devices, to prevent backflow of contaminated air (consider HEPA filtration).

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B.8.19. Supply Vents and Diffusers: Supply vents and diffusers shall be directed away from the face of Biosafety Cabinets, fume hoods, and incubators.

B.8.20. Supply – Outside Air Intake: Outside air intakes shall be separated as far as practicable from the points of exhaust with respect to prevailing wind patterns of the geographical area.

B.8.21. Biological Safety Cabinets (BSC)

B.8.21.1. BSCs and other primary containment devices are required in the BSL3 Containment.

B.8.21.2. Only biological safety cabinets listed in the latest edition of the *National Sanitation Foundation (NSF) Standard 49* (Class II Laminar Flow Biohazard Cabinetry) shall be installed.

B.8.21.3 A Class II, Type A2 cabinet with an exhaust canopy or thimble connection for discharge into the building exhaust system is recommended where work will consist primarily of microbiological work, using only minute or trace amounts of volatile hazardous chemicals,.

B.8.21.4. A Class II, Type B2 cabinet is recommended where applications could include work with more than minute quantities of volatile chemicals, or work with chemicals for which the physical properties or hazards are unknown or are known to present special hazards,. These cabinets provide 100% exhaust with no recirculation into the room or BSC. The cabinet should be interlocked with the building exhaust system to prevent pressurization of the cabinet.

B.8.21.5 Each BSC shall be on an independent electrical circuit and shall be connected to emergency power.

B.8.21.6. BSCs shall not be installed as an integral part of a room(s) supply and exhaust system in such manner that fluctuations of the room supply and exhaust air cause the biological safety cabinets to operate outside their design parameters for containment.

B.8.21.7. It is recommended that BSCs or fume hoods not be used as the sole source of room exhaust.

B.8.21.8. BSCs shall be located away from doors, from room supply louvers, and from heavily traveled laboratory areas.

B.8.21.9. Follow manufacturer's recommendations for required clearance to permit cleaning and testing of filters.

B.9. Fixed Laboratory Equipment

B.9.1. Autoclave (Decontamination Equipment): A method for decontaminating all wastes generated within the BSL3 located in the containment barrier shall be provided. A dedicated double-door (pass-through) autoclave with interlocking doors that is located and sealed on BSL3 containment barrier is recommended. The autoclave area requires

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overhead exhaust, floor drains (to BSL3 waste drains), electricity, hot/cold water, steam, heating, ventilation, and air conditioning (HVAC), and drain, waste, and vent (DWV).

B.9.1.1. Exhaust: High air velocity exhaust canopies shall be installed above each autoclave door. The exhaust from an autoclave contains a significant amount of moisture. Thus, filtration of this exhaust, when necessary, shall be through a moisture-resistant (hydrophobic) filter such as a Pall 0.2 micron filter or equivalent. Note that filtration of moist exhaust through a cold filter housing containing a paper HEPA filter will result in the destruction of the HEPA filter and a break in integrity.

B.9.1.2. Drain: Drain must be located inside the BSL3 containment laboratory with a bioseal between the BSL3 containment and the non-containment area or covered with a HEPA filtered cabinet.

B.9.2. Continuous Flow Centrifuges (and other equipment with potential to produce aerosols): Laboratory equipment with potential to produce aerosols shall be contained in devices that exhaust air through HEPA filters before discharge into the laboratory (or vented to the outside if it is dispersed away from occupied areas and air intakes.)

B.9.3 Disinfectant Fogging Machine: Consider providing facilities outside of BSL3 Containment to facilitate activation of portable disinfectant fogging machines inside BSL3 Containment area. (110V duplex power outlet inside airlock with switch outside.)

B.10. Systems Identification: All systems serving a BSL-3/ABSL-3 containment facility shall be clearly, permanently labeled with a biohazard symbol and identified as serving BSL-3/ABSL-3, including all conduit, plumbing and drain systems, HVAC equipment and ductwork, and panel boxes.

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Section P-5: ADDITIONAL REQUIREMENTS FOR LASERS AND MAGNETS

Division P-1, Sections A and B, "Applicability of the Laboratory Design Standards" is hereby made part of this Section by reference.

A. Laser Lab Design

A.1 All Class 3b or Class 4 lasers that are not imbedded in a Class 1 laser system should be installed in a properly designed laboratory.

- A.1.1 Warning signs shall be posted at all entrances to the room.
- A.1.2 Entryway warning lights or a lighted sign indicating when the laser power is on shall be installed on the exterior of the room.
- A.1.3 Reflective materials and surfaces shall be minimized.
- A.1.4 The room housing the laser shall be capable of being locked (but shall maintain egress to prevent entrapment of occupants).
- A.1.5 Windows and doorways shall be capable of being covered with non-combustible coverings.
- A.1.6 A carbon dioxide fire extinguisher shall be provided in the room.
- A.1.7 For Class 4 lasers with an unenclosed beam path, entry way curtains or the entrance door must be interlocked with the laser's power supply (unless the intended use of the laser would be adversely affected) and an emergency shutoff/panic button shall be installed in an immediately accessible area within the room, preferably near the entrance.

B. Magnet Lab Design

B.1 Magnet Locations

- B.1.1 NMR and MRI magnets shall be located in areas with restricted access to the public.
- B.1.2 No work stations shall be designed or placed within the 5 gauss field of a magnet. The 5 gauss line should not extend into public thoroughfares or building egress routes.
- B.1.3 Magnetic fields must remain within the limits of the room or occupied area realizing that normal wall, ceilings and floor materials do not block static magnetic fields. In the case of an NMR magnet, the strongest magnetic fields may occur at the bottom and top where shielding is less, which means that consideration must be given to occupied areas above and below the magnet.
- B.1.4 At least one magnetically compatible fire extinguisher should be mounted immediately external to magnet rooms.

B.2. Room Size

- B.2.1 For NMR magnets, the magnet room must be large and high enough to accommodate the helium cloud resulting from a quench (loss of superconducting field). During a quench, one half of the helium volume (between 40 and 100 liters for most NMR magnets) will boil off and be violently ejected from the helium vent on top of the magnet within one minute. This vapor cloud will seek the highest point in the room as it warms and expands up to

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700 times in volume. During the next few minutes the remaining helium will boil off. Nothing can be done to stop a magnet quench once it begins.

- B.2.2 An NMR magnet room should always be sized so that space between the ceiling and the level of seven feet in the room is large enough to contain the initial volume of helium gas released from a quench. There must be adequate exhaust ventilation in the room of at least 10 air changes per hour.

B.2.2.1 An NMR magnet room shall have adequate ceiling heights to allow for cryogen transfer into top-filling cryogenic magnets.

- B.2.3 For MRI units which utilize larger volumes of cryogens or for NMR magnets or in smaller rooms, helium vent pipes hard-ducted to the helium quench valve or automated exhaust fans tied to oxygen monitors shall be installed.

- B.2.4 Supplemental ventilation, oxygen alarms and emergency procedures shall be established when magnets are installed in below grade pits. These are particularly important for NMR magnets because liquid nitrogen vapors will collect in low areas and expand to create an oxygen deficient environment.

B.3 Signage

- B.3.1 Approved signage shall be posted at all entrances to NMR magnet rooms prohibiting entry by unauthorized personnel and conspicuously warning of magnetic fields.
- B.3.2 A visible indicator demarcating the 5 gauss line shall be installed after magnet start up. A permanent floor marking is recommended.

B.4 Commissioning of Magnets and Laser Labs and start-up of Equipment

- B.4.1 During the design phase of these laboratories, the Professional shall consult with the lab User, the PM, the representative from EH&S and the manufacturer of the equipment and develop specification requirements for commissioning of the labs, emphasizing coordination issues between the Commissioning Agent and the equipment start-up contractor, as applicable.
- B.4.2 Because of the significant hazard posed by liquid nitrogen vapors in below grade NMR labs, only experienced personnel should be allowed in the room during start-up.