UNC LABORATORY DESIGN GUIDELINES

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I. INTRODUCTION

A. BACKGROUND

Purpose: UNC-Chapel Hill has a continuing need to modernize and upgrade its facilities. The resulting construction projects often have significant health and safety requirements due to regulatory oversight. Since these requirements can impact the design of a project, Environment, Health and Safety (EHS) prepared this EHS Laboratory Design Guide to aid the campus community with planning and design issues. EHS believes that the Guide, in conjunction with EHS's plan review and consultation, improves design efficiency and minimizes changes. The main number for the UNC-EHS Office is (919) 962-5507.

Application: The Guide is a resource document for use by faculty, staff, and design professionals for use during the planning and early design phases of a project. The Guide applies to construction projects for all UNC-Chapel Hill facilities, including leased properties.

Format of Guide: The Guide is formatted to address laboratory design issues pertinent to General Laboratories (e.g.: chemical laboratories) in Section 1, with additional requirements for Radioactive Materials Laboratories and Biosafety Level 2 Laboratories presented in Sections 2 and 3 respectively. Within the sections, specific design criteria are provided. Comments are included under the specific design criterion to give the user the rational behind the design feature.

References: Please note that if any Design Guidelines are less stringent than the current NC Building Code, Mechanical Code, Fire Prevention Code etc., it should be brought to the attention of the EHS Department for discussion and revision as necessary. The Design Guidelines are not intended to preempt NC Code without State approval of Alternate Methods and Materials, where these Guidelines are found to be less stringent.

1. *Design criteria are designated in the following ways:*

a) Shall: Criterion is typically mandated by applicable regulation(s). The user of the Guide is required to include the design feature.
b) Must: Criterion is based on well-established consensus standards//guidelines. "Must" is used to reflect a UNC requirement, although not required by a regulation. The user of the Guide is required to include the design feature.
c) Should: Criterion is advisory in nature, based on good engineering and safety practices. It is the discretion of the user of the Guide to include the design feature.

2. *Limitations of the Guide:*

The EHS Laboratory Design Guide is not "all inclusive." It does not cover all regulatory issues nor does it cover all design situations. It is important to note that use practices must be considered during the design process, as they can directly influence how the laboratory will be designed (e.g.. how hazardous materials are used impacts how they are stored, which is a design issue). In all cases, EHS should be consulted on questions regarding health, safety, and the environment.

3. *General Requirements for UNC-Chapel Hill Laboratories*

a) Codes, Standards, and References

i. *Regulations:*

1. Federal Code of Regulations ("CFR"), Title 29, Labor
2. NC Building Code
3. NC Fire Prevention Code
4. NC Mechanical Code

5. CDC Select Agents, Title 42, Chapter I, Part 72 – Interstate Shipment of Etiologic Agents
6. National Fire Protection Association ("NFPA") Handbook 70

ii. *Conditions for Human Occupancy (ANSI/ASHRAE 55-1992)*

1. NC Radiation Protection Section
2. "Safe Handling of Radioactive Materials", National Council on Radiation Protection (NBS 92) Handbook
3. "Safe Handling of Radionuclides", International Atomic Energy Agency, Safety Series No. 1, (1973 ed. is still current as of 1999) (IAEA)
4. CDC-NIH Biosafety in Microbiological and Biomedical Laboratories, 4th (or latest) Edition
5. Guidelines for Research Involving Recombinant DNA Molecules (NIH Guidelines), April 2002 (or latest)
6. Reducing the Risks of Nonstructural Earthquake Damage: A Practical Guide, Federal Emergency Management Agency: FEMA74, 1994

b) Scope

The primary objective in laboratory design is to provide a safe environment for laboratory personnel to conduct their work. Therefore, all health and safety hazards must be identified and carefully evaluated so that protective measures can be incorporated into the design. The basic laboratory design features listed in this section illustrate some of the basic health and safety elements to include in all new and remodeled laboratories at UNC. The subsections of Section 2.1 provide specific guidance on additional critical features of a general laboratory (e.g., fume hoods, hazardous materials storage, and compressed gases.) (Keep in mind, however, that no matter how well designed a laboratory is, improper usage of its facilities will always defeat the engineered safety features.)

c) Architectural Considerations

i. *Walls/Doors/Security*

The laboratory must be completely separated from outside areas (i.e., must be bound by four walls).

The laboratory shall have means of securing hazardous and radioactive materials (i.e., lockable doors)

ii. *CDC Select Agents*

Having secured hazardous materials storage will keep unauthorized personnel from gaining access to them. These regulations apply specifically to laboratories containing radioactive materials and CDC Select Agents; however, UNC-Chapel Hill EHS interprets this to include all laboratories (e.g., general chemistry and electronics).

Laboratories which may use select agents should have wires (power/control/ data) pulled to the doors leading to these work areas for additional security control. (Discuss with UNC-EHS)

Doors in H-occupancy laboratories shall have doors which swing in the direction of egress. Doors serving B-occupancy shall swing in the direction of egress if the occupant load is 50 or more. Where possible, all B-occupancy lab doors should swing out with hardware satisfying ADA requirements.

On the hallway wall next to each door entry into a laboratory space must have a standardized clear frame with the room number permanently affixed with space for an 8.5x11 inch hazard warning sheet insert (landscape orientation).

Each door into a laboratory room must have a view panel.

Inside the laboratory, on the wall adjacent to the door latch, provide 2 feet of clear space for light switches, telephone, thermostat and fire extinguisher.

Vents are prohibited in laboratory doors which open to egress/access corridors.

Laboratories which use hoods or other larger equipment should be equipped with doorways that have 48 inch openings. Each opening should accommodate a 36 active door leaf and a 12 inch inactive leaf.

iii. Windows

If the laboratory has windows that open they must be fitted with insect screens.

iv. Flooring

The floor must be a one piece non-pervious and with covings to the wall. This can be achieved by use of glue, heat welded vinyl flooring, epoxy coated concrete slab, etc.

Floors should be coved up walls and cabinets to ensure spills cannot penetrate underneath floors/cabinets. Tiles and wooden planks are not appropriate because liquids can seep through the small gaps between them. These references apply specifically to laboratories containing biological and radioactive materials; however, UNC-Chapel Hill EHS interprets this to include all laboratories (e.g., general chemistry, electronics, etc.).

Floors in storage areas for corrosive liquids shall be of liquid tight construction.

v. Sinks

Each laboratory must contain a sink for hand washing. Elbow or electronic sensing faucet controls are recommended particularly for biological agents and/or highly toxic chemicals.

Sink faucets and hose bibs that are intended for use with attached hoses must be equipped with back siphon prevention devices.

Laboratory sinks shall have lips that protect sink drains from spills.

Sink lips or berms should be >= 0.25 inches and designed to completely separate the lab bench or fume hood work area from the sink drain.

vi. Chemical/Waste Storage

Chemical storage shelves shall not be placed above laboratory sinks.

Chemical storage shelves shall be flush to a back wall and shall have a ½ inch lip along the front edge.

Sufficient space or facilities (e.g., storage cabinets with partitions) shall be provided so that incompatible chemicals can be physically separated. This will be based on the chemical inventory and use projection provided by the Principal Investigator to the project and EHS. If the project scope cannot provide sufficient storage the user must develop a written management control plan to include as part of their local Chemical Hygiene Plan.

Materials, which in combination with other substances may cause a fire or explosion, or may liberate a flammable or poisonous gas, must be kept separate. Recommend that solvent storage not be located under the laboratory fume hood, as this is a location where fires are most likely to occur in laboratories.

Adequate space must be provided for the collection of waste materials.

Good Practice per UNC-Chapel Hill EHS

All labs should be designed to conveniently and safely accommodate the temporary storage of biological, radiological, and chemical wastes based on laboratory use projections. Wastes are generally stored in the lab in which they are generated, not in centralized accumulation areas. Contact EHS if waste storage and space become design challenges.

vii. *Furniture Design and Location/Exit Paths*

All furniture must be sturdy. All work surfaces (e.g., bench tops and counters) must be impervious to the chemicals used. (See Appendix to this section for suggested materials) For example, many microbiological manipulations involve concurrent use of chemical solvents such as formaldehyde, phenol, and ethanol as well as corrosives. The lab bench must be resistant to the chemical actions of these substances and disinfectants. Wooden bench tops are not appropriate because an unfinished wood surface can absorb liquids. Also, wood burns rapidly in the event of a fire. Fiberglass is inappropriate since it can degrade when strong disinfectants are applied. Fiberglass also releases toxic smoke when burned. These references apply specifically to laboratories containing biological and radioactive materials; however, UNC-Chapel Hill EHS interprets this to include all laboratories (e.g., general chemistry and electronics).

The lab shall have a minimum aisle clearance of at least 24 inches. Main aisles used for emergency egress must have a clearance width of at least 36 inches.

Lab benches and other furniture must be placed a minimum of 36 inches from an exit.

Lab desks should be located near exit ways and in the path of fresh make up air.

viii. *Cleanability*

The laboratory must be designed so that it can be easily cleaned. Walls should be painted with washable, hard non-porous paints.

Spaces between benches, cabinets, and equipment must be accessible for cleaning.

Laboratory furniture must have smooth, non-porous surfaces so as to resist the absorption of liquids and the harsh effects of disinfectants. Furniture must not be positioned in such a manner that makes it difficult to clean spilled liquids or conduct routine maintenance. For example, positioning a Class II biosafety cabinet in a limited concave space might not allow the biosafety cabinet certifier to remove panels of the cabinet when recertifying the unit. These references apply specifically to laboratories containing biological and radioactive materials; however, UNC-Chapel Hill EHS interprets this to include all laboratories (e.g., general chemistry and electronics).

ix. *Breakrooms*

The design of the laboratory building must incorporate adequate additional facilities for food storage/consumption and personal hygiene tasks outside of the rooms where chemical and biological materials are handled.

Break rooms should be sized based upon floor occupancy and must be dedicated as a break area and not serve other functions such as a copy center or equipment storage.

A minimum of 1 break room is required per floor unless separate desk space is provided for each occupant in office areas which are walled off and separately ventilated from the laboratory space.

x. *General Ventilation Considerations (see also Section 2.2 for fume hood considerations)*

Laboratory room supply should discharge through a perforated ceiling/plenum at velocities not exceeding 50 fpm. Supply terminal velocity at the face of the hood must not exceed 25 fpm or 30 per cent of the minimum face velocity (whichever is less).

The building DDC system should have spare capacity for building gas and vapor sensor inputs.

Sensor technology should be considered for emergency detection and alarm for highly hazardous gases or vapors.

Winter: 69-76 °F (at 35% RH); Summer: 73-79 °F (at 60% RH)

Consider providing chilled water line services to laboratories with significant heat loads.

Certain equipment may be specified to incorporate centrally produced chilled water and reduce water use and conditioned air.

Chilled water lines may be connected to portable fan coil units for spot cooling in rooms with high general heat loads.

Cabinetry or other structures or equipment must not block or reduce effectiveness of supply or exhaust air.

Good Practice per UNC-Chapel Hill EHS

Many supply diffusers and room exhaust room openings are located along laboratory walls. Storage of boxes near these openings may obstruct the circulation of air and supply or exhaust air functioning.

General laboratories must have a minimum of 6-air changes/hour.

OSHA requires a minimum of 6 AC/HR in chemical storage rooms. Since most laboratories store some quantities of chemicals, this regulation applies. OSHA has cited university chemical storerooms for inadequate ventilation under this regulation.

Laboratories should be equipped with an emergency exhaust button with reset capability located next to the exit door to provide up to 12 air exchanges per hour in the event of a chemical emergency (gas leak, volatile liquid spill, smoke, etc.)

Laboratories must be maintained under negative pressure in relation to the corridor or other less hazardous areas. High containment laboratories (P3) require air lock vestibules with door closing mechanisms so both doors are not open at the same time. Pressure differential detection systems (including magnehelic gages) must be installed with readouts/alarms located in a central panel. Consult with UNC EHS for special designs.

Clean rooms requiring positive pressure should have entry vestibules (anterooms) provided with door-closing mechanisms so that both doors are not open at the same time. Consult with UNC EHS for design details.

Air exhausted from the general laboratory space (as distinguished from exhaust hoods) must not be recirculated unless one of the criteria listed in ANSI/AIHA Z9.5 are met. Exhaust air from hoods is never recirculated.

General laboratory and Hood exhaust systems which pass conditioned building air through heat recovery systems require maintenance at the filtration/heat exchange units. These units should be maintainable without physical entry into the exhaust system.

If bodily entry is required into the ventilation system, isolation valves/dampers must be provided for each section being entered. Also, grade D air must be plumbed to the units to allow the use of supplied air respirator hoods or masks while working inside the ventilation system.

xi. Casework and counter top recommendations

1. Casework:

   Type: Standard, floor mounted, closed-base type (may have access doors), should be used in all laboratories.

   Materials: Metal or Hardwood (such as oak or other approved equivalent) - should be used in:

   a. General research and teaching laboratories where humidity and temperature will be normal (standard for occupied rooms), where casework maintenance is not a compelling factor, and where flammable, corrosive, or toxic substances will not be absorbed into the surface.
   b. Plastic Laminate - Should be used in:
      (i) Miscellaneous storage and workrooms requiring base or wall storage facilities, and where the infusion of appropriate colors may be architecturally desirable.
      (ii) Only non-combustible and non-reactive laminates may be used where flammable or corrosive chemicals are to be stored or used.
   c. Millwork - Should not be considered for new construction. Variances may be considered on renovation projects on a case-by-case basis.
   d. Counter Tops:

      Chemical Reaction and Abuse Resistance - for chemical resistance work surfaces, either of the following should be used:

      (i) Type 1 - Composition Stone -- with a chemical resistant resin finish.
      (ii) Type 2 - Natural Quarry Stone -- with a chemical resistant finish.
      (iii) Type 3 - Solid Resin -- for chemical resistant surfaces and in the bottom of general purpose fume hoods

      General Purpose - Areas where neither chemical nor physical abuse is expected and where no liquid services are to be used, such as 30" high desk and writing surfaces, instrument support surfaces, or storage areas may use either of the following:

(i) Type 4 - Wood Core -- A wood fiber or wood particleboard core with chemical resistant finish on all exposed surfaces.
(ii) Type 5 - Plastic Laminate -- Plastic Laminate surface with a wood particle core; may be selfedged or post-formed.
(iii) Radiation and Other Special Uses -- areas where radioactive materials or other special uses are approved should use the following:
(iv) Type 6 - Stainless Steel -- Type 316 polished stainless steel counter top surfaces may be approved on a case-by-case basis.

Physical Abuse Resistance - areas where abrasive physical abuse is expected; Physics, Earth Sciences, Geology, or Paleontology laboratories shall use:

(i) Type 3 - Solid Resin -- with a chemical resistant surface, or
(ii) Type 7 - Composition Stone -- with a low gloss vinyl sealer.

Fume Hood Work Surfaces -- should be selected as follows:

(i) General Purpose Hoods - Type 3, Solid Resin (chemical resistant)
(ii) Radiation Hoods - Type 6 - (Type 316 Stainless Steel).
(iii) Perchloric Acid Hoods - Type 6 - (Type 316 Stainless Steel).
(iv) Special Purpose Hoods - Type 3, Solid Resin (chemical resistant)

Where these casework guidelines are not deemed suitable, alternates of equal or better quality and durability shall be discussed with the UNC Chapel Hill EHS Office.

Good practice per UNC-Chapel Hill EHS

d) Engineering Considerations

i. Electrical

Shall provide GFI protection to electrical receptacles above counter tops and within 6 feet of sinks. Receptacles that are not readily accessible or receptacles for appliances occupying dedicated space, which are cord-and-plug connected in accordance with NEC Section 400-7A (6-8), are exempted.

Circuit breakers should be located outside the lab. All breakers must be clearly labeled as to equipment, lighting and outlets served.

Good Practice per UNC-Chapel Hill EHS

In the event of an emergency, the laboratory may be unsafe to enter. Hence, the circuit breakers for key electrical appliances should be located outside the lab.

ii. Plumbing

Valves for building gas supply lines should be located outside the lab.

The flexible connections should be used for connecting gas and other plumbed utilities to any freestanding device including, but not limited to; biosafety cabinets, incubators, and liquid nitrogen freezers. Flexible connections should be appropriate for the pressure requirements and should be constructed of material compatible with the transport gas. A shutoff valve should be located within sight of the connection and clearly marked.

Sink drains traps must be transparent (e.g., made of glass) and easy to inspect or have drain plugs to facilitate mercury spill control.

Lab waste water lines shall be separate from domestic sewage and sampling points shall be installed in an easily accessible location outside the building.

The sampling point shall be installed at a location where all building lab wastes are discharged, before the lab waste line connects to the domestic waste line. The sampling point shall be designed so that it is perpendicular to the lab waste line, has a minimum 4 inch diameter, has a cleanout screw on cap and is protected by a Christie Box. The sampling point should not be located in an area where water from irrigation or flow from stormwater runoff can accumulate.

All gas and utility supply lines shall be clearly marked along their entire length through the building. One suggested marking scheme is outlined in SEFA 7, 1994 as follows:

Number	Service	Color	Code	Color of Letter
1	Cold Water	Dark Green	CW	White
2	Hot Water	Red	HW	White
3	Steam	Black	STM	White
4	Air	Orange	Air	Black
5	Gas	Dark Blue	Gas	White
6	Vacuum	Yellow	Vac	Black
7	Distilled Water	White	DW	Black
8	Oxygen	Light Green	OXY	White
9	Hydrogen	Pink	H	Black
10	Nitrogen	Gray	N	Black
11	All Other Rare Gases	Light Blue	Chemical Symbol	Black

4. Fume Hoods

The requirements of this Guide apply to all UNC laboratory buildings, laboratory units, and laboratory work areas in which hazardous materials are used, handled, or stored.

a) Fume Hood Location

Fume hoods should be located away from activities or facilities, which produce air currents or turbulence. Locate away from high traffic areas, air supply diffusers, doors, and operable windows.

Fume hoods should not be located adjacent to a single means of access to an exit. Recommend that hoods be located more than 10 feet from any door or doorway.

Fume hoods must not have large equipment located in front.

Hoods should not be located in room corners, near windows or near very cold equipment.

Fume hood openings should not be located opposite workstations where personnel will spend much of their working day, such as desks or microscope benches.

Fume hoods should not face each other across narrow aisles.

An emergency eyewash/shower station shall be within 10 seconds of each fume hood.

Per 8 CCR 5162, the requirement for an eyewash/shower is triggered when an employee may be exposed to substances, which are "corrosive or severely irritating to the skin or which are toxic by skin absorption" during normal operations or foreseeable emergencies. Fume hoods are assumed to contain such substances; hence, UNC interprets this regulation to mean that emergency eyewash/shower station shall be within 10 seconds of fume hoods.

An ADA emergency eyewash/shower shall be within 10 seconds of an ADA fume hood (minimally one ADA hood per laboratory floor).

The location of at least one ADA hood per floor will enable disabled individuals to conduct their research without having to transport chemicals, etc. in elevators.

b) Approved Equipment

All fume hoods shall meet the requirements of NFPA 45, Standard on Fire Protection For Laboratories Using Chemicals, and ANSI/AIHA Z9.5.

c) Selection/Types

i. General: Consider the following factors when selecting fume hood:

1. Room size (length x width x height)
2. Number of room air changes
3. Lab heat load
4. Types of materials used
5. Linear feet of hood needed based on
6. number of users/hood
7. frequency of use
8. % of time working at hood
9. size of apparatus to be used in hood, etc.

ii. Constant Volume Hoods: These hoods are recommended.

Good Practice per UNC-Chapel Hill EHS

These hoods permit a stable air balance between the ventilation supply and exhaust by incorporating a bypass feature. A restricted bypass is recommended to reduce the opportunity for hood leakage through the bypass caused by convection currents established when a heat source is used in a hood.

iii. Variable Air Volume (VAV) fume hoods: These hoods are an option.

Good Practice per UNC-Chapel Hill EHS

These hoods maintain constant face velocities by varying exhaust volumes in response to changes in sash position. Because only the amount of air needed to maintain the specified face velocity is pulled from the room, energy savings are possible when the sash is closed. However, these hoods cost more up front and the potential energy savings may not be realized at UNC, because users do not exercise good sash management (e.g., pull sash closed when not using hood). EHS's concerns with this technology are not related to the VAV hoods ability to protect the worker. To be viable, any design should show significant energy savings without having to rely on the end user. Also, system maintenance of the supply and exhaust systems is more technically demanding. Sufficient additional resources for system maintenance must be budgeted. Otherwise, failing exhaust hoods and laboratories may need to be shut down for the safety of the building occupants.

iv. *Supply or auxiliary air hoods: These hoods are not permitted for new construction.*

Good Practice per UNC-Chapel Hill EHS

It is very difficult to keep the air supply and exhaust of supply hoods properly balanced. In addition, the supply air is intemperate, causing discomfort for those working in the hot or cold air stream. As a result, the supply vent is often either shut or blocked off, which eliminates any potential benefit of this type of hood. Finally, the presence and movement of the user's body in the stream of supply air creates turbulence that degrades the performance of the hood.

v. *Ductless Fume Hoods:*

Portable, non-ducted fume hoods are generally not permitted; however, a portable hood may be used for limited applications (e.g., used inside of an existing hood for a special application, such as odor control or to enclose a microbalance). Such applications must be reviewed and approved by EHS on a case-by-case basis.

vi. *Perchloric Acid Hoods:*

Heated perchloric acid shall only be used in a laboratory hood specifically designed for its use and identified as "For Perchloric Acid Operations." (Exception: Hoods not specifically designed for use with perchloric acid shall be permitted to be used where the vapors are trapped and scrubbed before they are released into the hood.)

Perchloric acid hoods and exhaust duct work shall be constructed of materials that are acid resistant, non-reactive, and impervious to perchloric acid.

The exhaust fan should be acid resistant and spark-resistant. The exhaust fan motor should not be located within the duct work. Drive belts should not be located within the duct work.

Ductwork for perchloric acid hoods and exhaust systems shall take the shortest and straightest path to the outside of the building and shall not be manifold with other exhaust systems. Horizontal runs shall be as short as possible, with no sharp turns or bends. The ductwork shall provide a positive drainage slope back into the hood. Duct shall consist of sealed sections. Flexible connectors shall not be used.

Sealants, gaskets, and lubricants used with perchloric acid hoods, duct work, and exhaust systems shall be acid resistant and non-reactive with perchloric acid.

A water spray system shall be provided for washing down the hood interior behind the baffle and the entire exhaust system. The hood work surface shall be watertight with a minimum depression of 13 mm (½ inch) at the front and sides. An integral trough shall be provided at the rear of the hood to collect wash-down water.

The hood surface should have an all-welded construction and have accessible rounded corners for cleaning ease.

The hood baffle shall be removable for inspection and cleaning.

Each perchloric acid hood must have an individually designated duct and exhaust system.

vii. *Radioactive Material Use*

1. Laboratory hoods in which radioactive materials are handled shall be identified with the radiation hazard symbol.
2. Fume hoods intended for use with radioactive isotopes must be constructed of stainless steel or other materials that will not be corroded by the chemicals used in the hood.
3. The interior of all radioisotope hoods must have coved corners to facilitate decontamination.
4. The hood exhaust may require filtration by HEPA or Charcoal/HEPA filters. Where such is the likelihood, the hood must have a bag-out plenum for mounting such filters and fan capacity for proper operation of the hood with the filter installed. The most appropriate location for the plenum is near the exhaust port of the fume hood (i.e., proximal to the hood).
5. Hoods used for radioactivity should have sashes with horizontal sliding glass.
6. The cabinet on which the hood is installed shall be adequate to support shielding for the radioactive materials to be used therein.
7. In general, glove boxes with HEPA filtered exhausts shall be provided for operations involving unsealed radioactive material that emit alpha particles. Consult with the Radiation Safety Office for specific requirements.

viii. *American with Disabilities Act (ADA) Hoods:*

Must consult with UNC Chapel Hill's ADA Compliance Office regarding the number lab hoods to install in facilities, which are accessible to and usable by individuals with disabilities – recommend minimally one ADA hood per laboratory floor. These hoods must provide appropriate work surface heights, knee clearances, reach to controls, etc. to individuals in wheelchairs.

The location of at least one ADA hood per floor will enable disabled individuals to conduct their research without having to transport chemicals, etc. in elevators.

ix. *Glove Boxes:*

Glove boxes (positive and negative) must meet the type, design and construction of requirements ANSI/AIHA Z9.5

x. *Floor mounted (walk-in) Fume Hoods:*

These hoods must meet the type, design and construction requirements of ANSI/AIHA Z9.5

xi. *Special Purpose Hoods:*

These hoods include enclosures for operations for which other types of hoods are not suitable (e.g., enclosures for analytical balances, histology processing machines, special mixing stations, evaporation racks). These hoods must be designed per ANSI Z9.5 and the Industrial Ventilation manual.

d) Labeling

Laboratory hoods and special local exhaust ventilation systems (SLEV) shall be labeled to indicate intended use (e.g., "Perchloric Acid Hood").

A label must be affixed to each hood containing at least the following information from the last inspection:

i. *certification date due*
ii. *average face velocity*
iii. *inspector's initials*

See the Campus Laboratory Hood and Ventilation Policy

e) Construction, Installation & Performance

New hoods can be mounted above a chemical storage cabinet provided that the cabinet meets the International Fire Code requirements for construction.

Type 316 stainless steel should be used for all parts of the fume hood system ventilation duct as long as compatibility is maintained.

Fume hood interior surfaces shall be constructed of corrosion resistant, non-porous, noncombustible materials such as type 316 stainless steel. These materials shall have a flame spread index of 25 or less when tested in accordance with NFPA method 255, Standard Method of Test of Surface Burning Characteristics of Building Materials. New hoods must not contain asbestos materials. Hoods used for perchloric acid digestion shall have interiors constructed of stainless steel and be equipped with perforated spray pipes behind the top of the baffles for periodic wash downs.

Hood inserts are only permitted for radioactive iodination procedures specifically approved by the UNC Radiation Safety Officer.

Laboratory hoods shall be provided with a means of containing minor spills.

The means of containing minor spills might consist of a 6.4-mm (¼ in.) recess in the work surface, use of pans or trays, or creation of a recess by installing a curb across the front of the hood and sealing the joints between the work surface and the sides, back, and curb of the hood.

There must be a horizontal bottom airfoil inlet at the front of the hood.

Adjustable baffles with horizontal slots must be present in the fume hood interior at the back and top.

Before a new fume hood is put into operation, an adequate supply of make up air must be provided to the lab.

f) Face Velocity:

Average air velocity at the hood face must be between 100-120 linear feet per minute (LFM) with a minimum of 90 LFM at any measured point at a minimum vertical sash opening of 18 inches. For combination sashes, the face velocity with the vertical sash down and two panels open must be 100 fpm and must pass the ASHRAE 110 tests at constant volume when the sash is raised to the full open (setup) position.

g) Certification:

The criteria for new fume hood installations at UNC-Chapel Hill are:

The average face velocity of the fume hood is between 100-120 fpm at an 18-in sash height or, for the combination sash, 100-120 fpm with the vertical sash closed and two horizontal sashes open.

All single-point velocity measurements are 90 fpm or greater at the specified minimum openings.

Fume hood containment is shown using the ASHRAE 110 smoke test and tracer gas tests in 3 test conditions:

i. *Two horizontal sashes open (vertical sash lowered)*

ii. *Vertical sash at 18 inches*
iii. *The sash fully open.*

Fume hoods with a vertical sash only must pass the ASHRAE 110 testing for the 18 inch and full open sash positions.

Where the required velocity can be obtained by partly closing the sash, the sash and/or jamb shall be marked to show the maximum opening at which the hood face velocity will meet the face velocity requirements.

An airflow indicator and alarm shall be provided and located so that it is visible from the front of the fume hood. In addition, a magnehelic gauge mounted on the front of the hood and connected to the hood throat shall be installed to monitor hood suction.

Hood alarms will sound locally and should be annunciated at the central Energy Management system computer through the DDC system.

Baffles shall be constructed so that they may not be adjusted to restrict the volume of air exhausted through the laboratory hood. Manual dampers shall be locked in position as soon as the system is balanced.

Fans should run continuously without local control from hood locations and independently of any time clocks unless specifically exempted by the UNC EHS Department.

For new installations or modifications of existing installations, controls for laboratory hood services (e.g., gas, air, and water) should be located external to the hood and within easy reach.

Shutoff valves for services, including gas, air, vacuum, and electricity shall be outside of the hood enclosure in a location where they will be readily accessible in the event of fire in the hood. The location of such a shut-off shall be legibly lettered in a related location on the exterior of the hood.

Each exhaust hood shall be permanently labeled with the unique identification number and the fan ID to which it is attached. Each fan on the roof shall be permanently labeled with its unique ID and a permanent listing of all room numbers, hoods and or general exhausts to which it is attached.

h) Power and Electrical

Chemical fume hood exhaust fans shall be connected to an emergency power system in the event of a power failure.

Emergency power circuits should be available for fan service so that fans will automatically restart in proper sequence upon restoration after a power outage.

Fume hood ventilating controls should be arranged so that shutting off the ventilation of one fume hood will not reduce the exhaust capacity or create an imbalance between exhaust and supply for any other hood connected to the same system.

In installations where services and controls are within the hood, additional electrical disconnects shall be located within 15m (50ft) of the hood and shall be accessible and clearly marked. (Exception: If electrical receptacles are located external to the hood, no additional electrical disconnect shall be required).

Hood lighting shall be provided by UL-listed fixtures external to the hood or, if located within the hood interior, the fixtures shall meet the requirements of NFPA 70, (National Electrical Code) and NFPA 45.

The light fixtures must be of the fluorescent type and replaceable from outside the hood. Light fixtures must be displaced or covered by a transparent impact resistant vapor tight shield to prevent vapor contact.

i) Sashes

Sashes may be horizontal, vertical, or a combination, and must have the capability to close off the hood face substantially.

Sash panels (horizontal sliding) must be 12 to 14 inches in width.

Sashes shall be made of safety glass.

Use laminated safety glass when internal temperature is anticipated to be less than 160 °F.

Use tempered safety glass when high internal temperatures are anticipated that will result in sash surface temperatures greater than 160 °F.

j) Ducting

Hood exhausts should be manifold together except for:

i. *Perchloric acid hoods*
ii. *Hoods with wash down equipment*
iii. *Hoods that could deposit highly hazardous residues on the ductwork*
iv. *Hoods requiring HEPA filtration or other special air cleaning*
v. *Situations where the mixing of exhausted materials may result in a fire, explosion, or chemical reaction hazard in the duct system*

Manifold fume hood exhaust ducts shall be joined inside a fire rated shaft or mechanical room, or outside of the building at the roofline.

Horizontal ducts must slope at least 1 inch per 10 feet downward in direction of airflow to a suitable drain or sump.

Ducts exhausting air from fume hoods should be constructed entirely of noncombustible material. Gaskets should be resistant to degradation by the chemicals involved and fire resistant.

Automatic fire dampers shall not be used in laboratory hood exhaust systems. Fire detection and alarm systems shall not be interlocked to automatically shut down laboratory hood exhaust fans.

Duct linings shall have a flame spread index of 25 or less when tested in accordance with NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials. Test specimens shall be of the minimum thickness used in the construction of the duct or duct lining.

Duct linings are not recommended. If they are installed then they must meet the above requirement.

Air exhausted from laboratory work areas shall not pass unducted through other areas.

k) Exhaust

New exhaust fans should be oriented in an up-blast orientation.

Hood exhaust stacks shall extend at least 10 feet above the roof. Discharge shall be directed vertically upward.

If parapet walls are present, EHS recommends that stacks extend at least 2 feet above the top of a parapet wall or at least 10 feet above the roof, whichever is greater.

Note: The University Architect/Planning Office must be contacted if any building features, such as exhaust stacks, extend above the roofline.

Hood exhausts shall be located on the roof as far away from air intakes as possible to preclude re-circulation of laboratory hood emissions within a building. For toxic gas applications, the separation distance shall be at least 75 feet from any intake.

As future gas necessities are difficult to predict, EHS recommends at least 75 feet for all applications.

All building exhaust and air intakes must be modeled to demonstrate that the exhaust air (including generator exhaust) will not be recirculated within the building being constructed nor in nearby buildings. At a minimum, computer modeling must be used while wind tunnel modeling may be more appropriate for complex building and terrain interactions.

Discharge from exhaust stacks must have a velocity of at least 3,000 fpm. Achieving this velocity should not be done by the installation of a cone type reducer. The duct may be reduced, but the duct beyond the reduction should be of sufficient length to allow the air movement to return to a linear pattern.

Rain caps that divert the exhaust toward the roof are prohibited.

Fume hood exhaust is not required to be treated (e.g., filtered or scrubbed) except when one of the following substances is used with content greater than the percent specified by weight or volume:

i. *Chemical CAS Reg # (Percent)*
ii. *2-Acetylaminofluorene 53963 (1.0)*
iii. *4-Aminodiphenyl 92671 (0.1)*
iv. *Benzedrine (and its salts) 92875 (0.1)*
v. *3, 3'-Dichlorobenzidine 91941 1.0*
vi. *4-Dimethylaminoazobenzene 60117 (1.0)*
vii. *alpha-Naphthylamine 134327 (1.0)*
viii. *beta-Naphthylamine 91598 (0.1)*
ix. *4-Nitrobiphenyl 92933 (0.1)*
x. *N-Nitrosodimethylamine 62759 (1.0)*
xi. *beta-Propiolactone 57578 (1.0)*
xii. *bis-Chloromethyl ether 542881 (0.1)*
xiii. *Methyl chloromethyl ether 107302 (0.1)*
xiv. *Ethyleneimine 151564 (1.0)*
xv. *1, 2-Dibromo-3-Chloropropane*
xvi. *Asbestos*
xvii. *Vinyl Chloride*
xviii. *Acrylonitrile*
xix. *Inorganic Arsenic*
xx. *Ethylene Dibromide*
xxi. *Ethylene Oxide*
xxii. *Methylene Chloride*

When used for radioisotope work. In this instance, the fume hood exhaust treatment system must be approved by the UNC Radiation Safety Officer prior to installation and use.

Air exhausted from laboratory hoods and other special local exhaust systems shall not be recirculated.

Exhaust fans shall be located outside the building housing the laboratory or in a separate room that is maintained at negative pressure to the rest of the building and provides direct access to outside for fan discharge ducts.

The minimum penthouse exhaust flow rate is 1 air change per hour.

l) Noise

System design must provide for control of exhaust system noise (combination of fan generated noise and air-generated noise) in the laboratory. Systems must be designed to achieve an acceptable Sound Pressure Level (SPL) frequency spectrum (room criterion) as described in the 1991 HVAC Applications Handbook.

The preferred method of exhaust noise control is with low static loss air valves and reduced exhaust fan speeds.

Noise attenuators may be used as a last resort if constructed of 304 stainless steel and no packing material is used.

m) Testing

Proper operation of fume hoods must be demonstrated by the contractor installing the fume hood prior to project closeout. The recommended containment performance test is ANSI/ASHRAE 110 with the acceptable criteria as specified in ANSI/AIHA Z9.5.ANSI/AIHA Z9.5, 5.6

5. *Emergency Eyewash and Safety Shower Equipment*

a) Regulations, Consensus Standards, and References

Consensus Standards and References:

i. *American National Standards Institute (ANSI), Z358.1*
ii. *Emergency Eyewash and Shower Equipment*
iii. *National Fire Protection Association*
iv. *Health Care Facilities, Handbook 99, Chapter 10-6, Emergency Shower*

b) Scope

This Guide presents the minimum performance requirements for eyewash and shower equipment or the emergency treatment of the eyes or body of a person exposed to injurious materials. It covers the following types of equipment: emergency showers, eyewash equipment, and combination shower and eyewash or eye/face wash.

A plumbed eyewash shall be provided for all work areas where, during normal operations or foreseeable emergencies, the eyes of an employee may come into contact with a substance, which can cause corrosion, severe irritation, or is toxic by skin absorption. Drench hoses, sink faucets, or showers are not acceptable eyewash facilities. Plumbed eyewash shall be provided at all work areas where formaldehyde solutions in concentrations greater than or equal to 0.1% are handled.

NFPA 99 Chapter 10-6

An eyewash safety station should be installed within all acid washing areas. An eyewash safety station should be installed in N2 dispensing stations and film processing areas using chemical developers and fixers.

An emergency shower shall be provided for all work areas where, during normal operations or foreseeable emergencies, areas of the body may come into contact with a substance which is corrosive, severely irritating to the skin or is toxic by skin absorption.

A deluge shower shall be provided at all work areas where formaldehyde solutions in concentrations greater than or equal to 1% are handled.

NFPA 99 Chapter 10-6

A deluge shower should be installed within all acid washing areas. A deluge shower should be installed in N2 dispensing stations and film processing areas using chemical developers and fixers.

c) General Location

i. *Where to Install*

Emergency eyewash facilities and deluge showers shall be in unobstructed and accessible locations that require no more than 10 seconds for the injured person to reach along an unobstructed pathway (i.e., no doors without panic bars or which don't swing open when pushed). If both eyewash and shower are needed, they shall be located so that both can be used at the same time by one person.

ANSI Z358.1, 4.6.1 and 5.4.4

NFPA 99, Chapter 10-6

American with Disabilities Act (ADA) Emergency Eyewash/Showers: Install an emergency eyewash/shower so that a disabled person can access it within 10 seconds of an ADA fume hood (minimally one ADA hood per laboratory floor). These emergency eyewash/showers must provide appropriate accessibility (e.g., activation of controls and height of eyecups) to individuals in wheelchairs.

The location of at least one ADA hood per floor will enable disabled individuals to conduct their research without having to transport chemicals, etc. in elevators. Fume hoods are assumed to contain substances which are "corrosive or severely irritating to the skin or are toxic by skin absorption," hence the need for emergency eyewash/shower stations.

ii. *Signage*

Emergency eyewash and shower locations shall be identified with a highly visible sign. The areas around the eyewash or shower shall be well lighted and highly visible.

ANSI Z358.1, 4.6

ANSI Z358.1, 5.4.5

iii. *Prohibitions around Equipment*

No obstructions, protrusions, or sharp objects shall be located within 16 inches rom the center of the spray pattern of the emergency shower facility.

ANSI Z358.1, 4.6.5

Electrical apparatus, telephones, thermostats, or power outlets should not be located within 18 inches of either side of the emergency shower or emergency eyewash facility (i.e., a 36-inch clearance zone).

Good Practice per UNC-Chapel Hill EHS

Prevent potential electrical hazards posed when the water generated by the activated emergency eyewash/safety shower is in proximity to live electrical equipment.

d) Eyewash Requirements

i. *Flushing Rates*

A means shall be provided to ensure that a controlled flow of flushing fluid is provided to both eyes simultaneously.

ANSI Z358.1, 5.1.1

Eyewash equipment shall be capable of delivering to the eyes not less than 0.4 gallons per minute of flushing fluid for 15 minutes.

ii. *Eyewash Positioning*

The eyewash unit shall be positioned with the water nozzles 33-45 inches from the floor and 6 inches minimum from the wall or nearest obstruction. The unit must be located at an operable sink.

ANSI Z358.1, 5.4.1

iii. *Equipment Activation*

The valve shall be designed so that the flushing fluid remains on without requiring the use of the operator's hands. The valve shall be designed to remain activated until intentionally shut off.

ANSI Z358.1, 5.2 (a)

ANSI Z358.1, 5.1.5

iv. *Eyewash Equipment Protection*

Nozzles shall be protected from airborne contaminants. The removal of the nozzle protection shall not require a separate motion by the operator when activating the unit.

ANSI Z358.1, 5.1.3

v. *Deluge Shower Requirements*

1. Deluge Shower Positioning

The emergency shower location must have a level surface beneath the shower head.

Good Practice per UNC-Chapel Hill EHS

Having a level surface will prevent the users from tripping while trying to access and use the emergency shower.

Emergency shower heads shall be designed so that a flushing fluid column is provided that is not less than 82 inches and not more than 96 inches in height from the surface on which the user stands.

ANSI Z358.1, 4.1

The shower head should not be mounted flush or recessed within any constructed surfaces or partitions and the center of the spray pattern shall be located at least 16 inches from any obstruction.

Good Practice per UNC-Chapel Hill EHS

ANSI Z358.1, 4.1

Recessing the shower head may limit access and/ or affect spray pattern.

The spray pattern shall have a minimum diameter of 20 inches at 60 inches above the surface on which the user stands

ANSI Z358.1, 4.1

2. Flushing Rates

Emergency shower heads shall be capable of delivering a minimum of 75.7 liters per minute (20 GPM) of flushing fluid.

ANSI Z358.1, 4.1

The shower should be attached to a flushing fluid supply from a 1-inch minimum iron pipe size (IPS).

Good Practice (based on ANSI manufacturer's test procedures)

vi. *Equipment Activation*

The valve shall be designed so that the flushing fluid remains on without requiring the use of the operator's hands. The valve shall be designed to remain activated until intentionally shut off.

ANSI Z358.1, 4.2

The manual actuator, triangle pull, shall be located not more than 69 inches above the surface on which the user stands. The manual actuator shall be free from obstruction for 18 to 24 inches in all directions. The actuator shall not be mounted flush or recessed within any constructed surfaces or partitions.

ANSI Z358.1, 4.3

vii. *Design for Maintenance/Use*

The water supply to showers and/or shower/eyewash combination units should be controlled by a shutoff valve which is visible and accessible to shower testing personnel in the event of leaking or failed shower head valves.

Good Practice per UNC-Chapel Hill EHS

This design will make maintenance easier.

When floor drains are used, a means shall be provided to control odors from dry traps.

If floor drains are not provided, controls shall be provided to prevent or minimize flooding.

viii. *Testing*

Proper operation of the equipment must be demonstrated by the contractor installing the emergency eyewash or shower equipment prior to project closeout and facility occupation.

Good Practice per UNC-Chapel Hill

By testing the equipment, UNC can be assured that it is working properly before the users begin their research.

ix. *Approved Equipment*

All emergency showers and eyewash facilities shall meet the requirements of NFPA 99 Chapter 10, and ANSI Z358.1 and shall be installed in accordance with ANSI Z358.1.

NFPA 99, Chapter 10

ANSI Z358.1

6. *Compressed Gas Cylinders*

a) Codes, Standards, and References

i. *NFPA 45, Chapter 8*
ii. *NFPA 99, Chapter 4*
iii. *NFPA 704, Chapter 2*

b) Scope

The Guide applies to all UNC-Chapel Hill facilities, including leased properties. It covers the design of storage for compressed gas cylinders. Note that there are numerous regulations governing the proper use of compressed gas cylinders; use is not addressed by the Guide, as it is a work practices issue, rather than design feature.

c) Storage of Compressed Gas Cylinders – General Location

Laboratory design shall include a storage area for cylinders of compressed gases where:

i. *They are protected from external heat sources such as flame impingement, intense radiant heat, electric arc, or high temperature steam lines.*
ii. *They are in a well protected, well ventilated, dry location, at least 20 feet from highly combustible materials.*

NFPA 99, 4-3.1.1.2

Design features which are prohibited: Unventilated enclosures such as lockers and cupboards.

Work practice issues: Oxygen cylinders shall not be stored near highly combustible materials, especially oil or grease, or near any other substance likely to cause or accelerate fire

d) Restraint Systems

Laboratory design shall include restraints for the storage of cylinders greater than 26 inches tall; the restraint system shall include at least 2 restraints (made of noncombustible materials), which are located at one-third and two-thirds the height of the cylinder.

NFPA 45, 8-1.5

NFPA 99, 4-3.1.1.2.3

A restraint system of chains, metal straps, or storage racks provides a reliable method of securing gas cylinders. Chains or a metal strap at the bottom and top one third of each cylinder provides protection against tipping and falling. [Work Practice Note: When compressed gas cylinders in service, they shall be adequately secured by chains, metal straps, or other approved materials, to prevent cylinders from falling or being knocked over.]

The purchase and installation of compressed gas cylinder securing systems must be subject to review and approval of EHS.

Good Practice per UNC EHS. EHS can assist in identifying good quality securing systems.

Gas cylinder securing systems should be anchored to a permanent building member or fixture.

Good practice

Provisions shall be made for securing cylinders that are delivered to locations outside of the laboratory.

7. Storage of Compressed Gas Cylinders - Toxic and Highly Toxic Gases

Laboratory design shall incorporate storage capabilities of compressed gas cylinders of toxic and highly toxic gases per the following table. The number of lecture bottle cylinders [approximately 5 cm x 33 cm (2 in. x 13 in.)] shall be limited to 25. See Table 6-1. Also, review the International building and fire codes for other limitations.

Flammable or Oxidizing Gases Liquefied Flammable Gases with Health Hazard Rating of 3

Table 6-1

	Flammable or Oxidizing Gases		Liquefied Flammable Gases		Gases with Health Hazard Rating of 3 or 4
	Sprinklered Space	Nonsprinklered Space	Sprinklered Space	Nonsprinklered Space	Nonsprinklered or Sprinklered Space
Max. no. of cylinders per 46.5m^2 (500 ft^2) or less	6	3	3	2	3

NFPA 45, Table 8-1

a) Storage Systems

Laboratory design shall include one of the following storage systems for toxic and highly toxic compressed gas cylinders:

i. *ventilated gas cabinets/exhausted enclosures/ laboratory fume hoods; or*
ii. *separate ventilated gas storage rooms without other occupancy or use, which has explosion control.*

When gas cabinets or exhausted enclosures are provided they shall (be):

i. *located in a room or area which has independent exhaust ventilation;*
ii. *operate at negative pressure in relation to the surrounding area;*
iii. *have self-closing limited access parts or noncombustible windows toprovide access to equipment controls, with an average face velocity of at least 200 fpm and with a minimum of 150 fpm at any part of the access port or window;*
iv. *connected to an exhaust system;*
v. *have self-closing doors and is constructed of at least 0.097 inch (12 gauge) steel;*
vi. *internally sprinklered;*
vii. *anchored;*
viii. *contain not more than 3 cylinders per gas cabinet, except where cylinder contents are 1 pound net or less, in which case gas cabinets may contain up to 100 cylinders.*

When separate gas storage rooms are provided they shall:

i. *Operate at a negative pressure in relation to the surrounding area;*
ii. *Direct the exhaust ventilation to an exhaust system.*

b) Treatment

Treatment systems for the exhaust of toxic and highly toxic gases must be reviewed and approved by EHS.

EHS reviews treatment systems to ensure they are compliant and are consistent.

c) Emergency Power

Emergency power shall be provided for exhaust ventilation, gas-detection systems, emergency alarm systems, and temperature control systems.

d) Detection System

A continuous gas detection system shall be provided to detect the presence of gas at or below the permissible exposure limit or ceiling limit. The detection system shall initiate a local alarm and transmit a signal to a constantly attended location. Activation of the monitoring system shall automatically close the shut-off valve on toxic and highly toxic gas supply lines to the system being monitored.

An approved supervised smoke detection system shall be provided in rooms or areas where highly toxic compressed gases are stored indoors.

e) Security

Storage areas shall be secured against unauthorized entry.

f) Storage of Compressed Gas Cylinders - Medical Gases

Enclosures such as 1-hour interior and exterior rooms (detailed below) must be provided for supply systems cylinder storage or manifold locations for oxidizing agents such as oxygen and nitrous oxide. Such enclosures must be constructed of an assembly of building materials with a fire-resistive rating of at least 1 hour and must not communicate directly with anesthetizing locations.

NFPA 99, Sections 4-3.1.1.2(a).2

Other nonflammable (inert) medical gases may be stored in the enclosure. Flammable gases shall not be stored with oxidizing agents. Storage of full or empty cylinders is permitted. Such enclosures shall serve no other purpose.

A 1-hour exterior room shall be a room or enclosure separated form the rest of the building by not less than 1-hour-rated fire-resistive construction. Openings between the room or enclosure and interior spaces shall be smoke-and draft-control assemblies having no less than a 1-hour fire-protection rating. Rooms shall have at least one exterior wall provided with at least two vents. Each vent shall not be less than 36 square inches in area. One vent shall be within 6 inches of the floor and one shall be within 6 inches of the ceiling. Containers of medical gases shall be provided with at least one fire sprinkler to provide container cooling in case of fire.

When an exterior wall cannot be provided for the room, automatic sprinklers shall be installed within the room. The room shall be exhausted through a duct to the exterior. Makeup air to the room shall be taken from the exterior. Both separate air streams shall be enclosed in a 1-hour-rated shaft enclosure from the room to the exterior. Approved mechanical ventilation shall be in accordance with the California Mechanical Code and provided at a minimum rate of 1 cubic foot per minute per square foot of the room area.

Medical gas system cabinets shall be in accordance with the following:

i. *Operated at a negative pressure in relation to surrounding area,*
ii. *Provided with self-closing, limited-access ports or noncombustible windows to give access to equipment controls. The average velocity of ventilation at the face of access ports or windows shall not be less than 200 feet per minute, with a minimum of 150 feet per minute at any point of the access port or window,*
iii. *Connected to an exhaust system,*
iv. *Provided with a self-closing door,*
v. *Constructed of not less than 0.097-inch (12 gage) steel, and*
vi. *Internally sprinklered.*

g) Flammable Liquid Storage Cabinets

i. *Codes, Standards, and References*

1. NC Fire Prevention Code Section

2. NFPA 30 Chapter 4

ii. Scope

Flammable liquid storage cabinets are intended for the storage of flammable and combustible liquids. This Guide applies to all UNC-Chapel Hill facilities, including leased properties. It covers the design, construction, and installation of Flammable Liquid Storage Cabinets; the Guide does not address the proper use of Flammable Liquid Storage Cabinets.

iii. Design

1. Approval/Submittal

Flammable Liquid Storage Cabinets must be UL listed and must meet NC Fire Prevention Code requirements.

Good Practice

UL listing and EHS approval assures a minimum level of quality consistent with code requirements and good practice.

2. Cabinet Capability

Where flammable liquid storage cabinets are required, they shall be designed such that they do not exceed 120 gallons for the combined total quantity of all liquids (i.e., Classes 1, 2, and 3).

NFPA 30, Chapter 4-3.1

NFPA 30 Chapter 4-3.1 still contains the limit (Check most recent NC Fire Protection Code)

One or more Flammable Liquid Storage Cabinets are required for laboratories which store, use, or handle more than 10 gallons of flammable or combustible liquids.

3. Labeling

Flammable Liquid Storage Cabinets shall be conspicuously labeled in red letters on contrasting background "FLAMMABLE - KEEP FIRE AWAY."

NFPA 30, Chapter 4-3.5

When flammable or combustible liquids present multiple hazards, the laboratory design shall address the storage requirements for each hazard.

For example, acetic acid is a corrosive and flammable material.

Therefore, if stored in a flammable cabinet with other flammable materials, it must be segregated through the use of separate barriers (e.g., secondary containment). Incompatible material shall not be stored within the same cabinet.

iv. Construction

1. Materials (NFPA 30, Section 4-3.3(b))

New Flammable Liquid Storage Cabinets must be constructed of steel.

Good Practice per UNC-Chapel Hill EHS

Wood cabinets are not UL listed or EHS approved.

Flammable Liquid Storage Cabinets shall be constructed as follows:

a. Minimum wall thickness of 0.044 inches (18 gauge).
b. Double walled construction with a minimum air gap of 1- 1/2-inches between the walls including the door, top, bottom, and sides.
c. Tight-fitting joints welded or riveted.
d. Liquid-tight bottom with a door sill of at least 2 inches.
e. Three-point latch on doors.

2. Doors

Cabinet doors shall be self-closing and self-latching.

3. Venting (NFPA 30, Chapter 4-3.4 and NFPA 99, Chapter 10-7.2.3)

Flammable Liquid Storage Cabinets are not required to be vented except for odor control of malodorous materials. Vent openings shall be sealed with the bungs supplied with the cabinet or with bungs specified by the manufacturer of the cabinet. If vented, cabinet should be vented from the bottom with make-up air supplied to the top. It shall be vented outdoors to an approved location or through a flame arrester to a fume hood exhaust system. Construction of the venting duct should be equal to the rating of the cabinet.

4. Location

Flammable Liquid Storage Cabinets shall NOT be located near exit doorways, stairways, or in a location that would impede egress. Flammable Liquid Storage Cabinets must NOT be wall mounted.

Good Practice per UNC-Chapel Hill EHS

Wall mounted cabinets are not UL Listed or Fire Marshal Approved.

5. Laboratory design must ensure that Flammable Liquid Storage Cabinets are NOT located near an open flame or other ignition source.
6. Good Practice per UNC-Chapel Hill EHS
7. An open flame or other ignition source could start a fire or cause an explosion if an accident or natural disaster brought the ignition source and flammable liquids or vapors together.

h) Hazardous Materials Storage and Handling

i. Standards

NC Building Mechanical and Fire Prevention Codes

ii. Scope

This design guide applies to the storage of hazardous materials. As noted in the introduction, the use of hazardous materials has direct bearing on the design of the laboratory; hence the research operations should be well understood in the planning phases when designing the laboratory's hazardous materials storage.

iii. *Requirements*

Laboratory design shall include spill control and secondary containment for the storage of hazardous materials liquids in accordance with the requirements of the NC Building Code, NC Fire Prevention Code and NFPA 45.

Notes: Design must allow for substances which, when mixed, react violently, or evolve toxic vapors or gasses, or which in combination become hazardous by reason of toxicity, oxidizing power, flammability, explosibility, or other properties, to be separated from each other in storage by distance, by partition, or otherwise, so as to preclude accidental contact between them.

Explosion control shall be provided for storage of non-exempt quantities of the following materials:

1. Highly toxic flammable or toxic flammable gases when not stored in gas cabinets, exhausted enclosures or gas rooms.
2. Combustible dusts.
3. Class 4 oxidizers.
4. Unclassified detonable and Class 1 organic peroxides.
5. Pyrophoric gases.
6. Class 3 and 4 unstable (reactive) materials.
7. Class 2 and 3 water-reactive solids and liquids.

When the hazardous materials stored in a control area are not in excess of the amounts specified in the International Building and Fire codes, such storage shall conform to the Building Code requirements for Group B Occupancy. (See Building and Fire Codes)

When the hazardous materials stored in a control area exceed the amounts specified such storage shall conform to the Building Code requirements for Group H, Occupancy.

When the hazardous materials stored in laboratories and similar areas used for scientific experimentation or research are not in excess of the table below and are not otherwise classified as Group B Occupancies, shall conform to the Building Code requirements for Group H.

iv. *Procedures*

Permitting and reporting procedures

1. NC Building Code Chemical Inventory Report Procedure

   As noted in this and other sections, the quantity of hazardous chemicals planned for use and storage within a project area has a direct impact on how the project is designed. The project architect is responsible for ensuring the necessary data is collected from the future building occupants and is assessed by a qualified individual (firm) before the Design Development Drawings are submitted to the State Department of Insurance (DOI). This review must be completed using standard Microsoft software (or other approved by the EHS Department). The end result of the procedure is a summarized report showing the quantities of hazard classes planned for designated control areas as compared to the NC Building Limits. For unassigned spaces, the assumptions made for these areas must be specified. A copy of the final report and all supporting information must be provided to the EHS Office on a Read Only optical disk as a permanent record of this analysis.

2. Hazardous Waste Generator "permit" for "off campus" facilities

   Projects within five campus sites are covered by the University's existing Hazardous Waste Generator permits (Horace Williams Airport, Cogen, HMF, Main Campus and Marine Sciences). Projects that are outside of these 5 areas must contact the Environmental Section of the UNC-Chapel Hill EHS Department for guidance and assistance.

3. City Water Quality Control

   All projects must be reviewed by the UNC Facilities Department if a new connection is made to the sanitary sewer. The University holds a comprehensive permit for the main campus. Sewer connections cannot be made until the building permit documentation has been submitted to the UNC Facilities Department.

4. Decommissioning of Existing Facilities

   Prior to completion of construction documents, contact the UNC-EHS Environmental Office to coordinate the preparation of a decommissioning plan.

   Chemical removal and cleaning of surfaces must be completed before demolition can begin. Decontamination of concealed areas such as pipes, and under cabinets etc. must be coordinated with demolition activity.

   All chemical waste and contaminated debris must be assessed by the UNC-EHS for hazard determination.

   The Environmental Office will assist in identifying appropriate waste handling methods.

   Hazardous waste must be managed according to all State and Federal regulations. All hazardous waste manifests must be signed by the Hazardous Waste Manager and shipped to UNC approved waste facilities.

i) Additional Requirements for Laboratories using Radioactive Materials, Radiation Producing Machines, or Lasers

i. Codes, Standards, and References

1. Regulations:

   a. NC Radiation Control Regulations (15A NCAC 11)
   b. NC Radioactive Material License,
   c. Code of Federal Regulation (CFR) 10, Parts 20 and 35
   d. UNC-Chapel Hill Radiation Safety Manual (STIPULATED IN LICENSE)

2. University Policies:

   Policies of the Administrative Panel on Radiological Safety

3. Recommendations:

   NC Radiation Protection Section

   "Safe Handling of Radioactive Materials," National Council on Radiation Protection (NBS Handbook 92)

"Safe Handling of Radionuclides," International Atomic Energy Agency (IAEA), Safety Series No. 1, (1973 ed. is still current as of 1999)

"Structural Shielding and Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10 Me", National Council on Radiation Protection, Report No. 49

"Radiation Protection Design Guidelines for0.1-100MeV Particle Accelerators," National Council on Radiation Protection, Report No. 51, (NCRP51)

Guide for the Preparation of Application for Medical Use Programs, (Proposed Revision2 to Regulatory Guide 10.8, USNRC (NRC 10.8)

Guide for the Preparation of Applications for Type A Licenses of Broad Scope, 2nd Proposed

Revision 2 to Regulatory Guide 10.5, Revision 2, USNRC (NRC10.5)

"CRC Handbook of Laboratory Safety, 4th Ed." CRC Press 1995, (CRCLAB)

"Recommendations for the Safe Use Of LASERS," American National Standards Institute. (ANSI Z136.1)

ii. *Scope*

All radioactive materials used at UNC-Chapel Hill are governed by the terms and conditions of the UNC-Chapel Hill Radioactive Materials Licenses, issued by the Department of Environment and Natural Resources, Division of Environmental Health, Radiation Protection Section. All radiation producing devices are registered with the State of NC, Radiation Protection Section.

iii. *Decommissioning of Existing Facilities Prior to Demolition or Renovation*

Contact the Radiation Safety Office as early as possible (at least 120 days) before the planned initiation of construction. A plan for decommissioning must be prepared following the UNC EHS Guidelines for decommissioning. The laboratory must be cleared of all radioactive sources/contamination before demolition, renovation or construction can begin.

iv. *Design Features for Radiological Labs*

1. Approval Process

Proposals for new facilities must be submitted to the Radiation Safety Office for review. New facilities may require the multiple approvals prior to construction.

NC Radioactive Material License

UNC-Chapel Hill Radiation Safety Manual

Shared facilities for the use of radioactive materials should not be included in plans for new buildings. If such facilities are deemed absolutely necessary, the facility must be under the direction, control and authority of a single principal investigator, who shall be accountable for maintaining the facility in a safe and orderly manner.

2. Architectural Considerations

Benches in laboratories must be capable of supporting weight of necessary shielding for gamma rays.

NBS Handbook 92

IAEA, Safe Handling of Radionuclides

When work involves gamma emitters (especially gamma irradiators) the floors and coatings must be able to support the gamma shielding.

NBS Handbook 92

IAEA, Safe Handling of Radionuclides

When work involves gamma emitters (especially gamma irradiators) the floors and coatings must be able to support the gamma shielding.

NBS Handbook 92

IAEA, Safe Handling of Radionuclides

When applicable, lead shielding must be incorporated in the structure. Based on the proposed type and quantities of radioactive materials, the Radiation Safety Program will determine the need for the shielding.

Note that for x-ray producing machines, shielding calculations will be performed by the Radiation Safety Office. Shielding design is to be in accordance with all applicable State Regulations and NCRP and ANSI standards. Designs must be submitted to the State through the Radiation Safety Office. During construction the shielding must be completion, the effectiveness of the installed shielding and protective design features shall be evaluated by the Radiation Safety Office and required reports submitted to and accepted by the State prior to operation of the radiation producing machine.

NC Radiation Control Regulations

National Council on Radiation Protection, Report No. 49

NC Radioactive Material License

3. Security

Areas where radioactive materials or other radiation sources are used or stored shall be provided with adequate security (e.g., locks) to prevent removal or use by unauthorized personnel.

NC Radiation Control Regulations

UNC-Chapel Hill Radiation Safety Manual

High radiation areas or very high radiation areas (as defined in 10 CFR 20.1602-2) shall be equipped with means to prevent inadvertent access and restrict access to only authorized personnel. Means to reduce exposure levels in the area may be required via an interlock device. In some applications, means to monitor the radiation levels in the areas shall be provided.

NC Radiation Control Regulations

10 CFR 20.1601-2

High radiation areas or very high radiation areas (as defined in 10 CFR 20.1602-2) shall be equipped with a control device that energizes a conspicuous visible or audible signal so that an individual entering the area and the operator of the device are made aware of the entry.

NC Radiation Control Regulations

10 CFR 20.1601-2

4. Waste Storage

   Adequate space must be available for radioactive wastes generated by projects within the lab. Most radioisotope projects will need about 10 sq. ft. of floor space for containers and shields within a lockable area.

   Radioactive wastes must be properly segregated by half-life categories.

   UNC-Chapel Hill Radiation Safety Manual

v. *Ventilation Considerations*

1. Ventilation requirements for the laboratories utilizing radioactive materials are dependent upon the types of materials used. Facilities that use radioactive gases shall be equipped with ventilation to adequately maintain concentrations to below allowable occupational exposure levels and to not permit escape of the gas to adjacent non-use areas such that concentrations exceed those allowed for uncontrolled areas. These range from no special requirements to those requiring separate exhaust systems equipped with "panic button" shut down switches. The Radiation Safety Program will review the proposed uses and make specific recommendations appropriate for each facility.

   10 CFR 20: Appendix B

   UNC-Chapel Hill Radiation Safety Manual

   Depending on the type and quantities of radioactive materials or the location of the facility, fume hoods used with volatile radioactive materials have specific design requirements. These are detailed in the Fume Hoods Section of this Design Guide.

vi. *Laser Radiation Items*

Class IIIb and IV Laser facilities must be equipped with adequate shielding (e.g. thermal curtains using materials approved by the University's Fire Marshall, window glass that does not transmit direct laser radiation or the specula or diffuse reflections of the laser radiation (shutters or filters)). Portals and viewing windows must be designed to prevent any exposure above the permissible threshold limit value.

ANSI Z136.1

CRC Handbook of Laboratory Safety, 4th Ed.

Class IIIb and Class IV laser facilities must in rooms secured by locks. Class IV laser installations must be provided with interlocked warnings that indicate the status of the laser prior to entering the facility.

ANSI Z136.1

Electrical outlets need to be positioned is such a manner that leakage of water coolant will not lead to risks of electrocution.

ANSI Z136.1

vii. *Laser Ventilation Considerations*

Appropriate ventilation to remove laser generated airborne contaminants must be provided for Class IIIb and IV lasers.

ANSI Z136.1

Gas cabinets and adequate ventilation must be provided to mitigate the hazards associated with excimer laser gases or other lasers using toxic gases.

ANSI Z136.1

j) Biosafety Level 2 Laboratories

i. *Codes, Standards, and References*

OSHA Blood borne Pathogens Standard

Biosafety in Microbiological and Biomedical Laboratories, 4th ed., pub #93-8395, CDC

National Fire Protection Association (NFPA) Standard 45, Fire Protection for Laboratories

The Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH).

Primary Containment for Biohazards: Selection, Installation and Use of Biological Safety Cabinets The Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH).

Guidelines for Research Involving Recombinant DNA Molecules, October 31, 1997, Federal Register, Vol. 62, No 211.

National Sanitation Foundation (NSF) International Standard 49

ii. *Scope*

All of the biological research conducted at UNC-Chapel Hill involves low to moderate risk etiological agents as defined by the NIH. Section 1 of this Guide, General Requirements for UNC Laboratories, covers all design requirements for Biosafety Level 1 laboratory work areas. This section focuses primarily on the biosafety considerations for a Biosafety Level 2 laboratory. Proposed Biosafety Level 3 labs will be reviewed on a case by case basis depending on what biohazard material the principal investigator plans to use.

1. Ventilation Considerations for Biosafety Level 2 Laboratories

   Air pressure in laboratories and animal care rooms should be negative in relation to the corridor or adjacent non-laboratory areas. Rooms housing immunocompromised animals should be at a positive pressure with respect to adjoining areas. Consult with UNC EHS Office for design details.

   CDC-NIH Biosafety in Microbiological and Biomedical Laboratories (ABSL 2, D.5)

   Good Practice per UNC EHS

   Potentially harmful aerosols can escape from the containment of the laboratory room unless the room air pressure is negative to adjacent non-laboratory areas. As a general rule, air should flow from low hazard to high hazard areas.

   Dedicated sterile tissue culture rooms should be balanced neutral or slightly positive with respect to adjoining areas. Tissue culture rooms that involve the use of biohazardous agents shall be negative as stated in C-1 above.

   Good Practice per UNC-Chapel Hill EHS

   This will minimize the potential for possible contamination of experiments within these rooms.

   An autoclave should be provided with a canopy hood with slotted exhaust or other suitable means of local exhaust. In addition, autoclave rooms should have a minimum of 10 air changes per hour.

   Good Practice per UNC-Chapel Hill EHS

   Unpleasant heat and odors will linger in the room unless provided with effective local exhaust and adequate frequency of air changes.

iii. *Biological Safety Cabinets and Other Containment Considerations*

1. Approval/Type

   All cabinets must be NSF listed, UL approved, and installed in accordance with the manufacturer's requirements.

   Good Practice per UNC-Chapel Hill

   Cabinets, which when used and installed properly, will provide both product and personnel protection. However, if the cabinet is not installed properly (e.g., not ducting a Class II, B2 cabinet), then it will not be serviceable. Installing a cabinet, which deviate from the listed NSF requirements, will void the NSF Standard 49 approved listing.

   For Biosafety Level 2 applications involving toxic chemicals or radionuclides, a Class II- B type cabinet must be installed.

   Good Practice per UNC-Chapel Hill EHS

   Class II-B cabinets do not allow in-room venting of exhaust air and are thus appropriate for such uses. For Biosafety Level 2 applications, fume hoods are not appropriate; a fume hood is not designed for the usage of biological materials. An appropriate biosafety cabinet must be used. The exact type of BSC should be specified early in the design process.

2. Location

Biological safety cabinets (BSCs) must be located away from doors and other high traffic areas.

NSF Standard 49, Annex E, I.A.1

Good Practice per UNC-Chapel Hill EHS

Currents of air can disrupt and degrade the protective capability of the cabinet. All attempts should be made to neutralize any interference.

A biosafety cabinet should not be installed directly opposite of another biosafety cabinet if spatial considerations allow otherwise.

NSF Standard 49, Appendix A

Good Practice per UNC-Chapel Hill EHS

Laminar airflow is greatly hindered by the operation of a biosafety cabinet located directly opposite of another biosafety cabinet or autoclave.

3. Restraints

When initially installed or reinstalled, biosafety cabinets must be provided with an appropriate means of seismic stabilization.

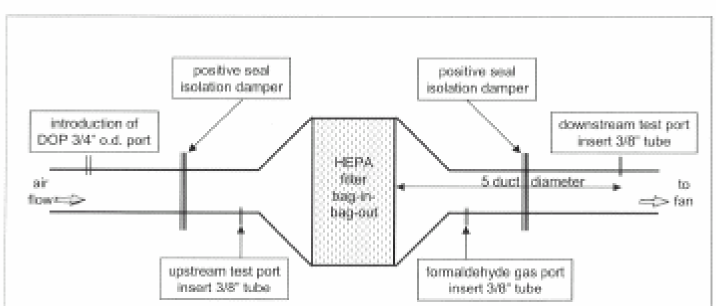
Good Practice per UNC-Chapel Hill EHS

(Note: The manufacturer should always be consulted to avoid possible damage to the pressurized cabinet volumes.)

4. Testing

Biological safety cabinets are to be certified as part of the building contract.

Remote HEPA Filtration Units in ductwork Remote HEPA filters must have provisions for testing and decontamination, with test ports before and after the HEPA, isolation dampers, and decontamination ports according to the drawing.



5. Autoclaves

   Laboratory designs must include an autoclave for sterilizing media, lab instruments, and medical waste as necessary.

   CDC-NIH Biosafety in Microbiological and Biomedical Laboratories (BSL 2, D.6)

   Guidelines for Research Involving Recombinant DNA Molecules (NIH Guidelines) App. G-II-B-4-f

   An autoclave is required since heat and pressure can kill potentially infectious spores that resist other disinfectants. The autoclave need not be in the actual lab room, however should be available on the floor. The investigator policies must be to transport medical waste in leak proof containers (in a sealed approved autoclave bag) if the autoclave is not in the room. The potential microbiological culture waste must be disposed in a manner consistent with the UNC Biosafety Manual section on biohazardous waste.

iv. Additional Considerations for HIV/HBV Research Laboratories

HIV/HBV research laboratories shall have vacuum lines which are protected with liquid disinfectant traps and high efficiency particulate air (HEPA) filters or filters of equivalent or superior efficiency. (Note: Filters must be maintained and routinely replaced, as necessary).

Liquid disinfectant traps and HEPA filtered vacuum lines prevent inadvertent contamination resulting from a release or backflow of liquid HIV/HBV contamination through a laboratory vacuum line.

HIV/HBV research laboratories shall contain a facility for hand washing and an eyewash facility which is readily available within the work area.

Containment equipment such as a sink and eyewash will expedite personnel decontamination in the event of a splash or spill on the body. For information on the appropriate eyewashes that meet EHS approval, review Section 1.2, Emergency Eyewash and Safety Showers in this Guide.

v. Glossary

1. Biohazardous Materials:

   Infectious agents, the products of infectious agents, or the components of infectious agents presenting a risk of injury or illness.

2. Biosafety Level:

   Biosafety levels consist of laboratory practices and techniques, safety equipment, and a laboratory facility appropriate for the operations performed and the hazard posed by the particular biohazard material. The Centers for Disease Control (CDC) and the National Institute of Health (NIH) define the four biosafety levels in the publication, Biosafety in Microbiological and Biomedical Laboratories, 1988 and revisions, and recommend biosafety levels for particular pathogenic microorganisms.

3. Biosafety Cabinet1:

   A ventilated cabinet which serves as a primary containment device for operations involving biohazard materials. The three classes of biosafety cabinets are described below:

4. Class I Biosafety Cabinet:

   The Class I biosafety cabinet is an openfronted negatively pressured ventilated cabinet with a minimum inward average face velocity at the work opening of at least 75 feet per minute. The exhaust air from the cabinet is filtered by a HEPA filter and discharged without recirculation.

5. Class II Biosafety Cabinet:

   The Class II biosafety cabinet is an open-fronted, ventilated cabinet. Exhaust air is filtered with a high efficiency particulate air filter (HEPA). This cabinet provides HEPA-filtered downward airflow within the workspace. Class II Cabinets are further classified as type A1, A2, B1, and B2.

   a. Class II, type A1

      Biosafety cabinets may have positive pressure contaminated internal ducts and may exhaust HEPA-filtered air back into the laboratory. The cabinet shall provide a minimum inward average face velocity of 75 feet per minute at the work opening.

   b. Class II, type A2

      Cabinets have all biologically contaminated internal ducts or plenums under negative pressure or surrounded by negative pressure ducts or plenums, exhaust HEPA filtered air through external ducts to space outside the laboratory, and have HEPA filtered down flow air that is a portion of the mixed down flow and inflow air from a common exhaust plenum.

   c. Class II, type B1

      Cabinets have all biologically contaminated internal ducts or plenums under negative pressure or surrounded by negative pressure ducts or plenums, exhaust HEPA filtered air through external ducts to space outside the laboratory, and have HEPA filtered down flow air composed largely of unrecirculated inflow air. Class II type B2 cabinets (also know as "total exhaust" cabinets) have all biologically contaminated internal ducts or plenums under negative pressure or surrounded by negative pressure ducts or plenums, exhaust HEPA filtered air through external ducts to space outside the laboratory, and have HEPA filtered down flow air drawn from the laboratory or outside air.

6. Class III Biosafety Cabinet:

   The Class III biosafety cabinet is a totally enclosed, negative pressure, ventilated cabinet of gas-tight construction. Operations within the Class III cabinet are conducted through protective gloves. Supply air is drawn into the cabinet through high-efficiency particulate air filters. Exhaust air is filtered by two high efficiency particulate air filters placed in series or by high efficiency particulate air filtration and incineration, and discharged to the outdoor environment without recirculation.

7. Boiling Point:

   The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure. For purposes of defining the boiling point, atmospheric pressure shall be considered to be 14.7 PSIA (760 mm Hg). California Fire Code Section 203, 204

8. Carcinogen:

A substance is considered to be a carcinogen if:

a. It has been evaluated by the International Agency for Research on Cancer (IARC) Monographs and found to be a carcinogen or potential carcinogen; or
b. It is listed as a carcinogen or potential carcinogen in the Sixth Annual Report on Carcinogens published by the National Toxicology Program (NTP) or,
c. It is regulated by Fed/0OSHA or Cal/OSHA as a carcinogen

9. Combustible Liquid:

A combustible liquid shall be defined as any liquid that has a closed-cup flash point at or above 100°F (37.8°C).

a. Class II Liquid. Any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C).
b. Class IIIA Liquid. Any liquid that has a flash point at or above 140°F (60°C) but below 200°F (93°C).
c. Class IIIB Liquid. Any liquid that has a flash point at or above 200°F (93°C).

10. Compressed Gas:

a. A gas or mixture of gases having a pressure exceeding 40 PSIA at 70_F in a container, or
b. A gas or mixture of gases having a pressure exceeding 104 PSIA in a container at 130_F, regardless of the pressure at 70_F, or
c. A liquid or mixture of liquids having a vapor pressure exceeding 40 PSIA at 100_F as EHS Design Guide Glossary

Revised: 10/02/00, Page3, determined by UFC Standard No. 9-5.

11. Containment:

The combination of personal practices, procedures, safety equipment, laboratory design, and engineering features to minimize the exposure of workers to hazardous or potentially hazardous agents.

12. Control Area:

A building or portion of a building within which the exempted amounts of hazardous materials are allowed to be stored, dispensed, used or handled.

13. Corrosive:

A substance that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. For example, a substance is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the U.S. Department of Transportation in Appendix A to 49 CFR Part 173, it destroys or changes irreversibly the structure of the tissue in 4 hours. This term does not refer to action on inanimate surfaces.

14. Decontamination:

Removal or destruction of infectious agents; removal or neutralization of toxic agents.

15. Emergency shower:

    A unit that enables a user to have flushing fluid cascading over the entire body.

16. Explosive:

    A substance that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

17. Eyewash:

    A device used to irrigate and flush the eyes.

18. Flammable Anesthetic Gas:

    A compressed gas which is flammable and administered as an anesthetic including cyclopropane, divinyl ether, ethyl chloride, ethyl ether and ethylene.

19. Flammable Liquid:

    Any liquid that has a closed-cup flash point below 100°F (37.8°C).

20. Class I Liquid:

    Any liquid that has a closed-cup flash point below 100°F (37.8°C) and a Reid vapor pressure not exceeding 40 PSIA at 100°F (37.8°C).

    a. Class IA liquids shall include those liquids that have flash points below 73°F (22.8°C) and boiling points below 100°F (37.8°C).
    b. Class IB liquids shall include those liquids that have flash points below 73°F (22.8°C) and boiling points at or above 100°F (37.8°C).
    c. Class IC liquids shall include those liquids that have flash points at or above 73°F (22.8°C), but below 100° F (37.8°C).
    d. California Fire Code Section 207

21. Flash Point:

    The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with air, near the surface of the liquid or within the vessel used.

22. Fume Hood:

    A device enclosed on three sides, as well as the top and bottom, with an adjustable sash or fixed partial enclosure on the remaining side. They are designed, constructed and maintained so as to draw air inward by means of mechanical ventilation, and so that any operation involving hazardous materials within the enclosure does not require the insertion of any portion of a person's body other than the hands and arms into the work area. (Note: Laboratory fume hoods prevent toxic, flammable, or noxious vapors from entering the laboratory, present a physical barrier from chemical reactions, and serve to contain accidental spills.)

23. Hazardous Material:

A material for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes materials which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. The term "physical hazard" includes materials for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, cryogenic, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive), or water-reactive.

24. Hazard Warning:

    Any words, pictures, symbols, or combination thereof appearing on a label or other appropriate form of warning that convey the health and physical hazards of the substance(s) present.

25. Highly Toxic:

    A substance is considered to be highly toxic if:

    a. A substance that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
    b. A substance that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
    c. A substance that has a median lethal dose (LD50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

26. HIV/HBV Research Facility:

    A laboratory producing or using research laboratory scale amounts of HIV or HBV. Research laboratories may produce high concentrations of HIV or HBV but not in the volume found in production facilities.

27. Irritant:

    A substance, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A substance is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of 16 CFR 1500.41 for 24 hours exposure or by other appropriate techniques, it results in an empirical score of 5 or more. Substance is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate techniques.

28. NIH:

    National Institute of Health

29. Nonflammable Medical Gas:

A compressed gas, such as oxygen or nitrous oxide, which is nonflammable and used for therapeutic purposes.

30. Organic Peroxide:

    An organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

31. Oxidizer:

    A substance, other than a blasting agent or explosive, that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

32. Pyrophoric:

    A substance that will ignite spontaneously in air at a temperature of 1300 F (54.40 C) or below.

33. Risk Levels:

    a. LOW RISK:

       Risk level of agents and/or operations having minimal effect on personnel, other animal or plants under ordinary use. This classification is restricted to all etiologic agents designated as Biosafety Level 1 by the CDC.

    b. MODERATE RISK:

       Risk level of agents/or operations requiring special conditions for control or containment because of (a) known pathogenicity to personnel, other animals or plants; (b) concentration; or (c) genetic alteration (synergistic effect) with other materials. This classification includes all etiologic agents designated as Class 2 or 3 by the CDC (Biosafety level 2 or 3) and oncogenic viruses specified as moderate risk by the National Cancer Institute (NCI).

    c. HIGH RISK:

       Risk level of agents and/or operations requiring additional control measures beyond those for moderate risk. This classification includes all etiologic agents designated Class 4 or 5 by the CDC and oncogenic viruses classified as high risk by the NCI.

34. Sensitizer:

    A substance that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the substance.

35. Toxic:

    A substance is considered to be toxic if:

a. A substance that has a median lethal dose (LD50) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
b. A substance that has a median lethal dose (LD50) of more than 200 milligrams per kilogram but not more than 1000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
c. A substance that has a median lethal dose (LD50) in air of more than 200 parts per million but not more than 2000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each. CCR, Title 24, Part 9, Section 221-T

36. Unstable (reactive):

A substance which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions or shocks, pressure or temperature.

37. Vapor Pressure:

The pressure, measured in PSIA, exerted by a liquid. California Fire Code Section 223

38. Water-reactive:

A substance that reacts with water to release a gas that is either flammable or presents a health hazard.

vi. Codes, Standards, and References

OSHA Blood borne Pathogens Standard, 29 CFR 1910.1030

Biosafety in Microbiological and Biomedical Laboratories, 4th ed., pub #93-8395, CDC

National Fire Protection Association (NFPA) Standard 45, Fire Protection for Laboratories

The Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH),

Primary Containment for Biohazards: Selection, Installation and Use of Biological Safety Cabinets The Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH),

Guidelines for Research Involving Recombinant DNA Molecules (NIH) Guidelines, April 2002,

National Sanitation Foundation (NSF)/ANSI International Standard 49, 2002

vii. Scope

Section 1 of this Guide, General Requirements for UNC Laboratories, covers all design requirements for Biosafety Level 1 laboratory work areas. This section focuses primarily on the biosafety considerations for a Biosafety Level 2 laboratory.

1. Ventilation Considerations for Biosafety Level 2 Laboratories

Air pressure in laboratories and animal care rooms should be negative in relation to the corridor or adjacent non-laboratory areas. Rooms housing immunocompromised animals should be at a positive pressure with respect to adjoining areas. Consult with UNC EHS Office for design details.

CDC-NIH Biosafety in Microbiological and Biomedical Laboratories (ABSL 2, D.5)

Good Practice per UNC EHS

Potentially harmful aerosols can escape from the containment of the laboratory room unless the room air pressure is negative to adjacent non-laboratory areas. As a general rule, air should flow from low hazard to high hazard areas.

Dedicated sterile tissue culture rooms should be balanced neutral or slightly positive with respect to adjoining areas. Tissue culture rooms that involve the use of biohazardous agents shall be negative as stated above.

Good Practice per UNC-Chapel Hill EHS

This will minimize the potential for possible contamination of experiments within these rooms.

An autoclave should be provided with a canopy hood with slotted exhaust or other suitable means of local exhaust. In addition, autoclave rooms should have a minimum of 10 air changes per hour.

Good Practice per UNC-Chapel Hill EHS

Unpleasant heat and odors will linger in the room unless provided with effective local exhaust and adequate frequency of air changes.

viii. *Biological Safety Cabinets and Other Containment Considerations*

1. Approval/Type

All cabinets must be NSF listed, UL approved, and installed and certified in accordance with the manufacturer's requirements and NSF/ANSI 49.

All cabinets must have a magnehelic gauge to indicate pressure drop across the HEPA filter.

Good Practice per UNC-Chapel Hill

Cabinets, which when used and installed properly, will provide both product, personnel and environmental protection. However, if the cabinet is not installed properly (e.g., not ducting a Class II, B2 cabinet), then it will not be serviceable. Installing a cabinet, which deviates from the listed NSF requirements, will void the NSF Standard 49 approved listing.

For Biosafety Level 2 applications involving minute quantities of volatile toxic chemicals or radionuclides, a Class II- B1 or B2 type cabinet must be installed.

For Biosafety Level 2 applications involving small quantities of volatile toxic chemicals or radionuclides, a Class II- B2 type cabinet must be installed.

Good Practice per UNC-Chapel Hill EHS

Class II-B cabinets do not allow in-room venting of exhaust air and are thus appropriate for such uses. For Biosafety Level 2 applications, fume hoods are not appropriate; a fume hood is not designed for the usage of biological materials. An appropriate biosafety cabinet must be used. The exact type of BSC should be specified early in the design process.

Type B cabinets must have audible and visible alarms that indicate a 20% loss of exhaust volume within 15 seconds. The internal cabinet fan must be interlocked to shut off at the same time the alarm activates.

NSF/ANSI Standard 49

Class II Type A cabinets shall not be ducted unless approved by EHS.

2. Location

Biological safety cabinets (BSCs) must be located away from doors, windows that open and other high traffic areas.

NSF Standard 49, Annex E, I.A.1

Good Practice per UNC-Chapel Hill EHS

Currents of air can disrupt and degrade the protective capability of the cabinet. All attempts should be made to neutralize any interference (i.e. room air supply diffusers, steam from autoclaves and dishwashers).

A biosafety cabinet should not be installed directly opposite of another biosafety cabinet or chemical fume hood if spatial considerations allow otherwise.

NSF Standard 49, Appendix A

Good Practice per UNC-Chapel Hill EHS

Laminar airflow is greatly hindered by the operation of a biosafety cabinet located directly opposite of another biosafety cabinet, chemical fume hood or autoclave.

Restraints

When initially installed or reinstalled, biosafety cabinets must be provided with an appropriate means of seismic stabilization.

Good Practice per UNC-Chapel Hill EHS

(Note: The manufacturer should always be consulted to avoid possible damage to the pressurized cabinet volumes.)

Testing

Biological safety cabinets are to be certified as part of the building contract.

Remote HEPA Filtration Units in ductwork

Remote HEPA filters must have provisions for testing and decontamination, with test ports before and after the HEPA, isolation dampers, and decontamination ports according to the drawing.

3. Autoclaves

Laboratory designs must include an autoclave for sterilizing media, lab instruments, and medical waste as necessary. The autoclave must have temperature and pressure readouts and a chart recorder.

CDC-NIH Biosafety in Microbiological and Biomedical Laboratories (BSL 2, D.6)

Guidelines for Research Involving Recombinant DNA Molecules (NIH Guidelines) App. G-II-B-4-f

NC Medical Waste Management Rules, Section .1200

An autoclave is required since heat and pressure can kill potentially infectious spores that resist other disinfectants. The autoclave need not be in the actual lab room, however should be available on the floor. The investigator policies must be to transport medical waste in leak proof containers (in a sealed approved autoclave bag) if the autoclave is not in the room. The potential microbiological culture waste must be disposed in a manner consistent with the UNC Biosafety Manual section on biohazardous waste.

BSL2 laboratories shall have vacuum lines which are protected with liquid disinfectant traps and high efficiency particulate air (HEPA) filters or filters of equivalent or superior efficiency. (Note: Filters must be maintained and routinely replaced, as necessary).

Liquid disinfectant traps and HEPA filtered vacuum lines prevent inadvertent contamination resulting from a release or backflow of liquid contamination through a laboratory vacuum line.

BSL2 laboratories shall contain a facility for hand washing and an eyewash facility which is readily available within the work area.

Containment equipment such as a sink and eyewash will expedite personnel decontamination in the event of a splash or spill on the body.

For information on the appropriate eyewashes that meet EHS approval, review Section 1.2, Emergency Eyewash and Safety Showers in this Guide.

(END OF SECTION)