# Board of Regents of the University System of Georgia

# Design Criteria for Laboratories

***Fifth Edition***

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# Acknowledgements

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# 2. SCOPE, PURPOSE AND GENERAL REQUIREMENTS

## 2.1. Primary Purpose

The primary purpose of this Design Criteria (DC) is to establish minimum design requirements for laboratory furniture, chemical fume hoods, HVAC, and closely related safety devices to provide a safe work environment and prevent undesirable exposures to laboratory hazards among students, faculty, and staff in University System of Georgia (USG) laboratories. This document is to provide guidance to architects, institutional staff designers, and safety professional. Institutions are encouraged to thoughtfully look at all aspects of design and are encouraged to balance energy savings, ease of maintenance, safety and recurring cost in design decisions.

## 2.2. Scope

This document is to be used for the design and renovation of teaching and research laboratories as well as science support spaces. For the purpose of this document a teaching laboratory is deemed to have structured occupancy and set experiments, as outlined by the course syllabus and course subject matter. A research laboratory has sporadic occupancy and the hazards are varied by experimentation being conducted. This document is not intended to include BSL3, BSL4, Vivaria, and other high hazard laboratories.

## 2.3. Minimum Standards

These design criteria are minimum design standards required for all new construction and renovation projects involving laboratory furniture, chemical fume hoods, and related support equipment in USG facilities. Individual institutions may have more stringent requirements. If any of the referenced codes, consensus standards, or guidance in this document conflict, then, the state Fire Safety minimum standards via the State of Georgia Fire Marshal or designee will prevail. In the event there is other conflicting guidance between institutional, BOR, building code requirements, then, the University System of Georgia Office of Real Estate & Facilities will make those determinations on a case-by-case basis through a request of the Vice Chancellor of Real Estate & Facilities or the Assistant Vice Chancellor for Planning & Management.

When possible, design standards can be performance-based, depending on specific conditions relevant to the proposed building and its surroundings, with adjustments made for monitoring or inspections. Mechanical and control systems need to be capable of easily reverting to these standards.

## 2.4. Hazard Assessment

Before a laboratory is designed, a thorough hazard assessment shall be conducted with the following criteria taken into consideration, chemicals to be

used, biological agents, lasers, radiation and other physical hazards, training, common practices, compliance history, specialized equipment and the ability to contain hazards.

## 2.5. Standard References

The primary design references for the DC are the **latest** versions of:

NFPA – National Fire Protection Association

- NFPA 30 – Flammable and Combustible Liquids Code
- NFPA 45 – Standard on Fire Protection for Laboratories Using Chemicals
- NFPA 70 – National Electric Code

ANSI – American National Standards Institute / AIHA – American Industrial Hygiene Association

- ANSI/AIHA Z9.5- Laboratory Ventilation
- ANSI Z9.2 – Fundamental Governing the Design and Operation of Local Exhaust Ventilation Systems
- ANSI Z9.5 – Laboratory Ventilation
- ANSI Z10 – Occupational Health and Safety Management Systems
- ANSI Z358.1 – Standard for Emergency Eyewash & Shower Equipment

ASHRAE – American Society for Heating, Refrigeration and Air Conditioning Engineers

- Standard 55 – Thermal Environment Conditions for Human Occupancy
- ASHRAE 110 – Method of Testing Performance of Laboratory Fume Hoods

ADAAG – Americans With Disabilities Act Accessibility Guidelines

- Official Code of Georgia Annotated (O.C.G.A.) 30-3-2.
- Energy Efficiency and Sustainable Construction Act of 2008 (O.C.G.A. § 50-8-18)

*(OSHA – U.S. US Department of Labor, Occupational Safety and Health Administration*

- Occupational Exposure to Hazardous Chemicals in Laboratories, 29 CFR 1910.1450
- Prudent Practices in the Laboratory 2011
- Biosafety in Microbiological and Biomedical, 5 edition
- NIH Guidelines for research involving Recombinant and Synthetic Nucleic Acid Molecules
- NSF/Ansi 49 Biosafety Cabinetry Certification

- Chapter 120-3-26 Ga State Rules and Regulations for Boiler and pressure vessels
- Compresses Gas Association Standards

The primary procedural reference for minor or major capital projects that exceed the institution's delegated authority is the Board of Regent's publication titled "*Building Project Procedures Manual*" (BPP). The BPP is available online at http://www.usg.edu/building_project_procedures/.

## 2.6. Drawings

### 2.6.1. Working drawings.

During the preliminary design phase of the project, vendor's or manufacturer's representative shall develop and submit a draft set of working drawings to the appropriate representatives at the institution (Facilities, Construction/Engineering, Environmental Health and Safety, and involved academic units) for review and comment.

Upon institution's approval of minor or major projects that exceed the institution's delegated authority, the preliminary design documents shall be presented to the Board of Regents of the University System of Georgia, Office of Real Estate & Facilities, 270 Washington St., S.W., Atlanta, GA 30334, for review and comment by the Board of Regents Facilities office staff. The Board of Regents Program Manager for the institution shall coordinate this meeting. Working drawings shall include floor plans and elevations of all laboratory casework, fixed installations, and other equipment. The Vice Chancellor for Real Estate & Facilities shall be the approving authority for preliminary design documents.

### 2.6.2. Shop drawings.

The vendor's or manufacturer's representative(s) shall submit shop drawings to the architect showing rough-in and installation drawings. Vendor's or manufacturer's representative(s) shall specify on the drawings the number of copies submitted and any special requirements. The primary project designer shall be responsible for resolving deviations between working drawings and shop drawings. Vendor's or manufacturer's representative(s) shall provide drawings in an approved electronic format if requested by the institution.

See also section V-F pertaining to chemical fume hood submittals.

### 2.6.3. Manufacturer's information.

Manufacturer's data and installation instructions shall be procured and submitted with all purchased equipment for the fit-up package (*ex*. fume hood,

biosafety cabinet, heat generating equipment, autoclaves) along with recommended ductwork seam connection methods and materials (if not welded).

#### 2.6.4. Samples.

All prospective bidders shall, upon request, submit samples.

#### 2.6.5. Final drawings.

After changes are made, vendor's or manufacturer's representative(s) shall develop a final set of working drawings, to be submitted in accordance with the most current version of the Board of Regents BPP.

## 2.7. Institution Review and Acceptance

#### 2.7.1. Design documents review.

Project design documents shall not proceed beyond preliminary design and shall not be presented to the Board of Regents for minor and major capital projects until they have been reviewed and endorsed by the institution's Facilities, Construction/Engineering, Environmental Health and Safety, and involved academic units. It is highly recommended that all stakeholders be made aware of changes and deviation to endorsed design documents.

#### 2.7.2. Construction documents.

All stakeholders should sign off on final construction documents.

#### 2.7.3. Test and balance reports.

New laboratory construction and renovation projects require a system test and balance report to verify proper HVAC system and chemical fume hood operation before the building or area will be accepted, or occupied, by the institution.

#### 2.7.4. Chemical Fume Hood Testing Reports.

All testing documentation shall be provided to the institution. All chemical fume hood testing (e.g. ASHRAE 110) shall include at minimum as installed (AI) and as manufactured (AM), prior to acceptance.

## 2.8. Variance Requests

Variance requests from this criterion, approved by institution departments, as outlined in E-1 above, shall be submitted as early as possible during schematic or preliminary design, in writing to the Board of Regents Vice Chancellor for Facilities. Such requests shall include the nature and proposed location of the variance, giving needed details of proposed changes. Variances that deviate

from existing fire code will require additional review and approval of the Fire Marshal's office.

These requests should be submitted to:

Vice Chancellor for Facilities
Board of Regents of the University System of Georgia
270 Washington St., S.W.
Atlanta, GA 30334

Variances approved by the Board or Regents will be in writing, from the Vice Chancellor for Facilities (or designee).

## 2.9. Chemical Fume Hoods Minimization

To minimize the overall number of chemical fume hoods needed in laboratories, USG institutions shall incorporate chemical use reduction strategies such as micro-scale and virtual (computer-simulated) experiments in chemistry labs to the maximum extent feasible. For new or significantly renovated laboratory buildings, the USG institution or design team shall provide a justification based on the hazard assessment for the number of hoods needed.

Chemical fume hoods shall not be installed or used primarily for chemical storage.

## 2.10. Laboratory Air Pressurization and Exchange Rate

### 2.10.1. Occupied air exchange rate.

Laboratories where potentially hazardous chemicals or agents are used and/or stored shall have negative air pressurization relative to surrounding space, and HVAC systems shall be designed to provide 6-10 air changes per hour, depending on use of laboratory space. Hazard assessments and administrative controls also can be used in the consideration of air exchange setbacks. In the event air exchanges are designed below 6 (six) air changes per hour, a variance must be requested.

### 2.10.2. Unoccupied air exchange rate.

In unoccupied laboratory conditions as low as 4 (four) air changes/hour may be permitted, provided the occupancy can be detected by motion sensors or other technology in accordance with good laboratory design practices. New technology (Smart Laboratories) may allow for lower air changes, however, these shall be evaluated on a case-by-case basis through the variance process.

#### 2.10.3. Emergency exhaust purge wall button.

An emergency exhaust purge wall button should be considered in each research laboratory, to be determined by good laboratory and engineering practice.

## 2.11. Local Exhaust Ventilation (other than chemical fume hoods)

Local exhaust ventilation (LEV) (e.g., “snorkels” or “elephant trunks”), other than chemical fume hoods, shall be designed to adequately control exposures to hazardous chemicals. An exhausted manifold or manifolds with connections to local exhaust may be provided as needed to collect potentially hazardous exhausts from gas chromatographs, vacuum pumps, excimer lasers, or other dedicated equipment or processes which can produce potentially hazardous air pollutants. Considerations should be made to not connect LEV’s to Manifold fume hood systems the contaminant source needs to be enclosed as much as possible, consistent with operational needs, to maximize control effectiveness and minimize air handling difficulties and costs.

It is recommended to evaluate all local exhaust ventilation on an annual basis (as per ANSI Z9.2-2018), manufacture’s specification or as deemed feasible by the institutional Environmental Health and Safety staff, Facilities Operations, or the academic department. Such testing may require test & balance verification and/or adjustment.

# 3. LABORATORY LAYOUT

## 3.1. Physical

#### 3.1.1. Aisle space.

Clear aisle space between cabinetry, benches and equipment shall be a minimum of 4 feet. Ceiling air diffusers and grills should be located to provide maximum air distribution and circulation and needed accessibility for airflow rate/volume testing without affecting proper operation of containment devices.

#### 3.1.2. Wall space.

Clear wall space inside and adjacent to the entry door shall be a minimum of 2 feet to allow for light switches, telephone, thermostats, and fire extinguisher. Consideration should also be made for PPE storage at the entry to allow for proper donning and doffing.

#### 3.1.3. Cabinet and shelf locations.

Cabinets and shelving shall not be located to allow for storage above 18 inches from the ceiling or directly under sprinkler heads to prevent stacked materials from impeding water flow.

#### 3.1.4. Equipment placement.

Floor space shall be planned for needed existing and anticipated equipment. Drawings shall show equipment with broken lines, crosshatches for existing equipment, and shaded areas for anticipated equipment.

#### 3.1.5. Doorway width.

Doorways into laboratories having chemical fume hoods and large equipment shall be self-closing and open in the direction of egress. They shall provide a leaf of 48 inch width or have an active leaf width of 36 inches and an inactive leaf width of 12 inches, providing an opening of 48 inches. Vented laboratory doors are prohibited.

#### 3.1.6. Flooring.

Flooring in laboratories shall be constructed of non-permeable material and shall be chemical resistant. Slip resistant matting, also constructed of non-permeable, chemically-resistant material, shall be provided where appropriate.

Outside offices should not be assessable only through laboratory spaces.

## 3.2. Airflow Patterns

#### 3.2.1. Air turbulence.

Laboratory size and layout clearances shall be coordinated with HVAC design and laboratory equipment placement to avoid creating turbulent air near chemical fume hoods or biological safety cabinets, and dead air pockets or reverse air currents along the sash opening. Chemical fume hoods or biological safety cabinets should be located as far away as practical from doors, corners, and GRD (grilles register diffusers). All efforts will be made to avoid dead spaces that create uneven air flow patterns in containment laboratory equipment.

#### 3.2.2. Chemical storage room HVAC.

Rooms intended for the storage of hazardous chemicals shall meet current NFPA 45 standard and shall have a non-recirculating exhaust air system.

# 4. GENERAL INFORMATION AND SPECIFICATIONS

## 4.1. Specification Criteria

This section shall be followed in preparing the technical specifications for laboratory furniture and chemical fume hoods. The format may be altered to conform to the architect's standard, but the content shall be the same.

## 4.2. Accessible Design

Laboratory furniture and equipment meeting the requirements of the Americans with Disabilities Act (ADA) shall be provided where necessary to comply with Georgia Code. In order to accommodate future ADA needs, flexible casework should be considered for teaching laboratory spaces.

## 4.3. Quality Assurance

### 4.3.1. Catalog numbers.

Manufacturer's catalog numbers shall be indicated on drawings to identify chemical fume hoods. Unless modified by drawing notation, or specified otherwise, manufacturer's current catalog description for indicated number, together with indicated or specified options or accessories, constitutes the requirements for each unit.

### 4.3.2. Design standard.

Use of catalog numbers, and specific requirements indicated on drawings are not intended to preclude use of products by other listed acceptable manufacturers but are given to establish a standard of design and quality for materials, construction and workmanship.

# 5. LABORATORY FURNITURE & FIXTURE SPECIFICATIONS

All casework, counter tops, utility service fixtures, and miscellaneous items of furniture shown on the drawings shall be furnished as described in this specification section. This includes delivery, unloading, unpacking, set-up, leveling and securing to walls and floors, and removal of all resulting debris. All equipment specified in this section shall be furnished only by manufacturers who have successfully demonstrated fixture compatibility through approved submittals.

## 5.1. Casework Design and Components

Casework shall be furnished according to construction documents. Casework includes base cabinets, wall and storage cases, reagent racks, shelving, pegboards, free-standing tables, miscellaneous furniture, knee space panels, filler panels, scribes and base molding.

### 5.1.1. Cabinetry materials.

Approved materials for cabinetry include:

a. Metal or hardwood (such as oak) in general research and teaching laboratories where humidity and temperature will be controlled, where casework maintenance is not a factor, and where planned laboratory activities are unlikely to cause flammable, corrosive or toxic substances to be absorbed into or corrode the surface.
b. Plastic laminate shall not be permitted for laboratory work surfaces in any new or renovated laboratory space. A variance will be needed for student work desks and computer stations.

### 5.1.2. Base cabinets.

a. Base cabinets shall be in accordance with the plans and elevation drawings as to size, location, and door and drawer configuration.
b. Knee space panels shall be used to enclose the rear portions of an area under an apron rail and between base cabinets to enclose the plumbing space or to shield between opposing assemblies, as in peninsular or island assemblies, and shall be secured with grommets and screws.
c. Scribes molding shall be used where casework or filler panels abut walls, columns, pilasters or other casework.
d. Filler panels shall be provided to enclose spaces between casework and abutting surfaces.
e. Casework shall be constructed with a flush-lipped overlap on all four sides of doors and drawers.

### 5.1.3. Wall cases.

a. Wall cases shall be in accordance with the plans and elevation drawings as to size and location. Consideration should be given to selection with regard to use and door style.
b. Bypass stops shall be included on all sliding doors.

5.1.4. Storage cases.

a. Storage cases shall have doors and shall be in accordance with the plans and elevation drawings as to size and location.
b. Bypass stops shall be included on all sliding doors.

5.1.5. Reagent racks and shelving.

Reagent racks and shelving shall be constructed of the manufacturer's standard materials for reagent shelving and be of the size and location as per construction documents.

Reagent racks, coated with a chemical-resistant finish, and of the size, configuration and location per contract documents.

a. Shelving shall have a ½-inch retaining lip or safety crossbar.
b. Free standing shelving height shall not exceed 5 feet from floor.
c. Shelving shall be coated with a chemical-resistant finish.

5.1.6. Pegboards.

a. Shall be constructed of manufacturers' standard materials for pegboards.
b. Pegboards shall be of the size and location as shown on the plans or elevation drawings.
c. Pegboards and Pegs shall be polypropylene or equivalent chemical resistant material or coated with a chemical-resistant finish.

5.1.7. Tables.

a. Tables shall be constructed of solid hardwood or metal with tops as specified below. Examples of approved tabletop materials include:

**i.** Composition stone – with a chemical-resistant finish or low-gloss vinyl sealer.

**ii.** Natural quarry stone – with a chemical resistant finish.

**iii.** Solid resin – compounded solid resin throughout.

b. Tables 36 inches or more in height shall be provided with leg stretchers.

5.1.8. Chairs and stools.

Laboratory chairs and stools provided shall have non-fabric coverings and be easily cleaned and disinfected. Materials that are easily cut or damaged should not be specified.

## 5.2. Casework Installation and Performance

5.2.1. Finished surfaces protection.

Finished furniture and equipment surfaces shall be protected from soiling and damage during handling and installation by keeping polyethylene film or similar protective covering over it until final installation.

5.2.2. Installation specifics.

Manufacturer's installation instructions shall be followed.

a. Base cabinets, alone or connected, shall be leveled and provide a firm foundation for counter tops, and, in assembly, screwed together, front and back, the front of the base cabinets being aligned with each other.
b. Scribe molding shall be secured to both the casework and abutting structures
c. Casework joints shall be squared. Wooden joints shall be glued and screwed in place.
d. Knee spaces, filler panels and scribe molding shall be structurally integrated and of neat appearance.
e. Rigid molding (i.e., hard rubber or metal) shall be furnished and installed along the backs of toe spaces, exposed ends of casework and around

open knee spaces. All molding shall be caulked and sealed with chemically-resistant material.

f. Cabinet door catches and drawer stops shall be well-aligned.
g. Cabinet base anchors shall be provided and installed.
h. Wall cases shall be secured to walls (metal stud walls shall be reinforced) with no less than 4 fasteners per wall case, 2 each in both the top and bottom of wall case. Wall cases within the same room shall be level with each other, whether or not in the same assembly, and all wall cases shall be plumb.
i. The base of wall cases shall be positioned at least 54 inches above the finished floor, or as detailed on the drawings.
j. Storage cases shall be installed plumb and attached to walls at the top and bottom with no less than 2 fasteners per case.
k. Reagent racks shall be mounted with the base of the uprights flush with the countertop, and fastened to prevent moving with at least 2 fasteners per upright.
l. Wall-mounted reagent shelving shall be installed flush with the wall. Each reagent shelf shall have a ½-inch retaining lip.
m. Floor-standing reagent racks shall be installed plumb.
n. Reagent shelves shall be secured to walls with at least 4 fasteners per rack, 2 each at top and bottom.
o. Tables shall be assembled and set in place with the specified top secured with fasteners on 12-inch centers.
p. Pegboards shall be mounted flush to walls and secured with at least 4 corner fasteners.
q. Cabinet doors and drawers shall open and close without sticking. Wall case and storage case doors shall operate without sticking.

### 5.2.3. Countertop materials.

Countertops include all work surfaces in laboratories, including backsplashes and end curbs. Countertop materials shall be of smooth finish, chemical resistant, durable, appropriate for intended use, and easily cleaned and disinfected. Chemical resistant laminate surfaces are not an approved countertop material for wet research or teaching laboratories within the USG.

Examples of approved countertop materials include:

a. Composition stone – with a chemical-resistant finish or low-gloss vinyl sealer.
b. Natural quarry stone – with a chemical resistant finish.
c. Solid resin – compounded solid resin throughout.

5.2.4. Countertop configuration.

a. Countertops shall be as long as practical, based on a 72 or 96 inch module length, unless specified for shorter assemblies.
b. Countertops shall be one piece, 30 inches in depth (front to back), unless specified at shorter depth (24 inches).
c. Countertop sections, backsplashes, and curbs shall be secured with screws and chemical-resistant adhesive compound.
d. Countertops shall be a minimum of ¾ inch thick and have a drip groove along the underside of exposed edges.
e. Countertops, backsplashes and curbs shall have a ¼ inch radius on all exposed corners.
f. Backsplashes and curbs shall be 4 inches high, at least ¾ inch thick, and provided along the backs of countertops, abutting walls and taller furniture, and where columns and pilasters about the countertop.
g. End curbs on a 30 inch high countertop shall extend to the bottom side of any adjacent 36 inch high countertop.
h. All countertops shall have an overhang of 1 inch on all exposed edges and shall have cutouts for all specified service fixtures.

5.2.5. Countertop installation.

Countertops shall be installed and secured level, both along the length and width of the surface.

## 5.3. Service Fixtures

Service fixtures include all liquid, gas, air and electrical outlets, tank nipples and fasteners, laboratory sink bowls, cupsinks, and overflows. Utility service fixtures shall be furnished for plumbing and electrical outlets as described in these specifications or shown on the drawings.

5.3.1. Service fixture requirements / identification.

Plumbing service fixtures shall be laboratory grade with handles color-coded and labeled by type of service in accordance with the following schedule:

- Gas = blue
- Air = orange
- Vacuum = yellow
- Hot water = red
- Cold water = green
- Hot & cold mixing = red for hot, green for cold
- Steam = **black**

Gas, air and vacuum service fixtures should be positioned left to right (facing the fixtures) unless mounted on lab island counters accessed on both sides.

5.3.2. Cold water service fixtures.

Cold water service fixtures shall be provided with an integral vacuum breaker and female threaded to accept either an aerator or a 10-serrated hose connection end. End user to be consulted on final connection required and water conservation shall be considered. Hot and cold mixing water service fixtures shall be provided with an anti-splash spout. Deck-mounted hot, cold, and hot/cold mixing water service fixtures shall be fixed 6 inch gooseneck type unless otherwise specified. Water fixture valves shall be furnished as follows:

a. Cold water handle turns clockwise to “on” position.

b. Hot water handle turns counter-clockwise to “on” position.

5.3.3. Gas, air, vacuum service fixtures.

Gas, air, vacuum service fixtures shall have wing style handles.

5.3.4. Special water service fixtures.

Special water service fixtures for distilled, de-mineralized, de-ionized or filtered water service shall be polypropylene with self-closing valves.

5.3.5. Sinks.

a. Sizes of sinks, cup sinks, sink outlets, strainers, and overflows shall be as specified on the drawings.
b. Equipment furnished shall include the sink bowl, outlets, strainers, and overflow (2 inches below the inside top of the sink bowl).
c. The sink counter outlet shall be 1½ inch diameter overlapping interior sink dimensions by ½ inch or more on all four sides.
d. Sinks shall be designed and installed to allow for maintenance access to drain traps.
e. All wet labs shall contain a free standing sink available for hand washing.

5.3.6. Cupsinks (should be installed conservatively in consideration for valid need)

a. Cupsinks shall be 6 inch inside diameter, hemispherical at double-faced island and peninsular assemblies, *and/or* 3 inch by 6-inch oval configuration along wall assemblies, with secured strainer.
b. Cupsinks in chemical fume hoods will be installed to be at least a ¼" above the base working surface and/or have a cover provided to seal from accidental chemical spills.

5.3.7. Neutralization tanks.

a. Neutralization tanks whether located outside the building, underground, or under sinks in labs, shall be designed and located to provide for safe access and regular maintenance.
b. All such tanks shall be part of a preventive maintenance program.
c. An institution can opt out of installing a neutralization tank, provided the local municipality approves or if the BOR provides an exception based on documented evidence that such discharge will not violate local sewer ordinance requirements.

5.3.8. Bench-top drain troughs.

Bench-top drain troughs are not permitted in any newly constructed laboratories.

5.3.9. Floor drains.

a. Floor drains maybe designed and installed in newly constructed laboratories primarily for the purpose of preventing significant facility

damage in the event of a major water release or spill and to allow for the testing of safety showers.

b. The drains maybe equipped with flush-mounted caps so that inadvertently spilled chemicals or other undesirable materials will not enter the sanitary sewer system.
c. In addition, the neutralization tanks referenced in section IV-C.7 (if required) above shall provide a redundant means of containment for inadvertently spilled materials which may enter the drain system.
d. Users shall be instructed on the importance of regular and periodic drain maintenance (e.g. ensuring the drain traps do not dry out, checking the drain caps, etc.). Automatic trap primer valves or waterless trap seals shall be installed, as necessary, to prevent drying out of seldom-used floor drains.

#### 5.3.10. Electrical service fixtures.

Electrical service fixtures shall be the type specified or shown on drawings. Flush plates shall be stainless steel. Unless otherwise specified, the following electrical services shall be furnished:

a. 120-volts, single phase, 3-wire polarized duplex, single or double-face receptacles. Each receptacle shall be ground fault circuit interrupter (GFCI) protected whenever located within 6 feet of a water supply, including a shower stream. Cupsinks are exempted from this requirement.
b. 208-volts, single or 3-phase, 3 or 4-wire polarized receptacle.

#### 5.3.11. Electric circuits.

a. All electrical circuits within a laboratory shall be properly identified as to their service function within the circuit breaker panel.
b. Any ground fault circuit interrupter (GFCI) circuits shall be labeled as such.

### 5.4. Service Fixture Installation and Performance

All service fixtures shall be installed per manufacturer instructions and perform as designed when operational.

## 6. CHEMICAL FUME HOODS

## 6.1. Fume Hood Selection

### 6.1.1. Hood design.

a. Laboratory hoods are to be considered an integral part of the overall building HVAC system, should provide adequate safety for all users and be included in overall energy efficiency planning. Locations, abundance, size and design should be a collaborative effort between users, Environmental Health and Safety, Facilities Operations and design teams.

b. All new laboratory buildings constructed after July 2019 shall use high performance hoods and the associated integrated building infrastructure for general teaching and research laboratories. For significant renovation projects, the use of High performance hoods should also be considered. The use of radiological materials may require a higher volumetric flow-rate, however, the institution's EHS Director, Environmental Coordinator, Radiation Safety Officer, and/or Radiation Safety Committee should be consulted.

c. The Design Team shall do a pre-project analysis of fume hood safety and energy conservation strategies and present recommendations during the initial project-planning phase. Strategies to be considered should include such things as: modes of hood operation during work activity and after hours; use of heat recovery systems; automatic sash closures; use of horizontal sliding sashes, etc.

d. Recirculation of any laboratory fume hood exhaust air is prohibited.

e. Certain specific applications (i.e. Rad hoods) may require combination high efficiency particulate air (HEPA) and/or organic vapor (OV) filters (Bag in and Bag out) for laboratory chemical fume hoods. These hoods must be on individual exhaust duct systems.

f. All fume hood exhaust ductwork from chemical fume hoods will be constructed of stainless 316 or 304. All joints will be welded and ground smooth (interior), except for maintenance points and the initial connections to each fume hood. Any deviations from 316 will require an approved variance. Galvanized or 304 maybe considered for ductwork in manifold exhaust duct sections of systems where the air is well diluted.

g. Chemical polyvinyl chlorinated (CPVC) or combustible duct materials are prohibited for fume hood duct systems.

h. Manifold materials will be based on good safety and engineering principles and a risk assessment.

i. During schematic design, the institution user group(s) shall provide the designer with a completed risk assessment of the chemicals

programmed to be used to assist in the selection of appropriate exhaust duct materials.

j. Ductless chemical fume hoods are generally prohibited, however, an exception may be considered on a case-by-case basis by the Office of Facilities, in addition to the approval of State Fire Marshal's Office and the institution.

k. Low airflow safety alarm consoles shall be factory and field-tested and furnished with each fume hood. Airflow measuring devices shall be capable of indicating design flow-rates +/- 20% of the design. Airflow monitoring devices can consist of thermoanemometers, static pressure sensors, and/or suitable industry accepted devices.

#### 6.1.2. Recommended fume hood size.

a. Fume hood sizes shall be selected according to intended use and available space.

b. Three-foot and four-foot width hoods shall be selected when the intended use is for one person and when large apparatus set-ups are not anticipated.

c. Five-foot width hoods shall be selected when the intended use is for one or two people and where large apparatus may be set up some of the time.

d. Six-foot width general-purpose hoods shall be selected when the intended use is for two or more people, in teaching labs, or when unusually large apparatus may be set up a majority of the time.

e. Chemical fume hoods longer than six-feet are not permitted in any laboratory, since the hoods cannot exhaust effectively into a single duct chamber. Variances to this requirement may be considered on a case-by-case basis with proper justification and should be submitted to the Board of Regents Vice Chancellor for Facilities prior to beginning the project.

## 6.2. Fume Hood Airflow Requirements

#### 6.2.1. Airflow rate.

a. High Performance (low flow), CAV chemical fume hoods and VAV chemical fume hoods shall be designed to maintain a minimum average face velocity of 60-79 FPM with the sash open 18 inches, +/- 10%. Operating ranges 80-100 FPM shall be +/- 20%. The operating range of these hoods should be 60 – 100 FPM, which provides flexibility for programming changes in the use of the hood. This requirement applies to general purpose, special purpose, radiation, and perchloric acids hoods. NOTE: Processes, higher hazard chemical use, radiological

materials may require higher air flow rates, as required by regulation and/or the institution.

b. Standard bypass, VAV (with or without set-backs), or CAV (with frequency drive) shall be designed to maintain an average face velocity of 100 FPM +/- 20% while occupied and as low as 60 FPM +/- 10% while unoccupied, with a sash opening of 18 inches. This requirement applies to general purpose fume hoods. All setback hoods are required to have motion sensors capable of detecting motion within 1 foot of the side plain, at least 3 feet in front of the sash plane. Upon activation of the motion sensor, the VAV value must provide the occupied face velocity within 3 seconds.

"In use Fume Hood"- a hood with an ongoing experiment or a person working.

"Unoccupied Fume Hood"- hood that is empty and or no person in present.

#### 6.2.2. Prohibited chemical fume hoods.

a. Non-bypass constant volume chemical fume hoods are prohibited.
b. Auxiliary-air hoods are not permitted in new laboratory construction or renovation projects but may be considered on a case-by case basis for general-purpose and special-use hood activities only if special energy conditions or design circumstances exist. If approved, they must distribute in-flow air uniformly at the air supply opening at 70% or less of total exhaust volume. Down-flow velocity should not exceed 30 feet fpm at the plane of the down-flow air opening.

## 6.3. Fume Hood Types

Laboratory chemical fume hoods shall be either standard or high-performance bypass constant volume, or variable air volume (VAV).

#### 6.3.1. Standard bypass hoods.

Standard by-pass chemical fume hoods provide bypass air when the sash is closed to maintain exhaust air continuously at the same volume and may be selected for desired applications. Note: Non-bypass constant volume chemical fume hoods are prohibited. This type of hood shall apply to existing hood installations only. All new or replacement hoods shall be High Performance only.

#### 6.3.2. Variable air volume (VAV) hoods.

VAV chemical fume hoods have an air control device that varies the exhaust air volume in proportion to the hood face opening by either changing the

speed of the exhaust fan or adjusting an exhaust duct damper and may be selected for desired applications. These hoods can also be equipped with setback sensors that allow for occupied and unoccupied settings, regardless of the sash height during normal operations conditions.

#### 6.3.3. High performance.

High performance (low-flow) hoods, also known as the Berkeley 2 design, are specially designed hoods which improve aerodynamics around the hood entry, include a rear down flow baffle, flush air foil, and upper dilution air supply. These hoods create greater hood containment efficiency at lower flow rates such as 60 FPM. Other technologies may be included under this designation.

## 6.4. Fume Hood Applications

#### 6.4.1. General-purpose use.

A bypass type hood (e.g. High performance) with an airfoil and sash is often the hood of choice to remove vapors, fumes, particulates, or gases generated by chemical reactions in teaching and research laboratories involving acids, organic solvents, and radioactive materials. A stainless steel interior shall be specified for radiation work in this type hood.

Excluded operations from this type of hood include use of perchloric acid, highly toxic and unstable explosive materials.

#### 6.4.2. Radiation use.

This hood category is used for radioisotope work. Use of perchloric acid, highly toxic, and unstable explosive materials is excluded. Radiation auxiliary-air hoods are prohibited.

#### 6.4.3. Perchloric acid use.

A bypass hood with a duct and canopy wash-down system is used for laboratory experiments with perchloric acid compounds. These hoods shall not be used for work with sulfuric acid, acetic acid, organic solvents, or any combustible or water-reactive materials. Perchloric acid auxiliary-air hoods are prohibited.

#### 6.4.4. Special-purpose use.

A uniquely configured hood may be designed and used for a special laboratory purpose, such as enclosing analytical instrumentation or as a canopy device uniquely configured for exhausting nuisance odors, steam, heat or other physical stressors. The campus Environmental Health and Safety department or the BOR when no Environmental Health and Safety department exist shall be consulted during the design phase. Large walk in

and other specialty hoods should only be purchased after BOR prior approval. These type hoods may also be used for hazardous materials (highly toxic, unstable, explosive, corrosive, or reactive), provided they are constructed of materials compatible with the intended use and have appropriate filtration and other control measures in place.

## 6.5. Fume Hood Location

Chemical fume hoods shall be located per the requirements of ANSI Z9.5 (most recent version) to minimize excessive airflow cross-drafts in the laboratory, in accordance with good engineering practice.

In general, chemical fume hoods should not be located adjacent to a single means of access to an exit or any closer than 10 feet from any primary egress doorway. Fume hood openings should not be located opposite workstations where personnel will spend much of their working day, such as desks or microscope benches. An emergency eyewash/shower station shall be within approximately 10 seconds of each fume hood.

The addition of a new fume hood (or hoods) to an existing laboratory shall require design review and approval by the campus engineering and Environmental Health and Safety departments. This is necessary to determine the adequacy of the existing heating, ventilation and air conditioning system to handle the additional exhaust flow.

In general, lab bench work space or other routine work areas should not be located directly (e.g. 4') in front of chemical fume hoods without appropriate sensing controls and/or other monitoring devices.

## 6.6. Submittals

Shop drawings (required in 1-D-2 above) shall be coordinated with other work involved and submitted for chemical fume hoods showing:

### 6.6.1. Plans.

Plans to include elevation, ends, cross sections, service run spaces, service fixtures (type and location), location and details of anchorage and fitting to floors, walls, and bases.

### 6.6.2. Layout.

Layout units with respect to surrounding walls, windows and doors, lighting fixtures, HVAC registers and other building components, connection to hood exhaust system, location of access doors, cut-off valves and junction boxes, with rough-in drawings provided for mechanical and electrical services.

Equipment manufacturer's installation instructions shall be provided, along with their recommended duct connection method(s).

## 6.7. Fume Hood Components

### 6.7.1. Approvals.

Chemical fume hoods shall have UL approval. Approved manufacturers include those who have or may demonstrate through written certification, approved submittals, and performance data (including ASHRAE 110 test, latest version) that their fume hoods are capable of maintaining a sustained safe working environment for laboratory personnel.

### 6.7.2. Base cabinet size.

The hood base cabinet shall be as wide as the hood superstructure. Base cabinets shall be compatible with and strong enough to support the hood superstructure and countertop.

### 6.7.3. Supporting countertops.

Hood working surface countertops shall be as wide as the hood superstructure, strong enough to support it, and be compatible with designated hood service.

Countertops shall be provided with a 1/4$^{th}$ to ½-inch raised edge around the interior periphery of the fume hood for spill containment.

### 6.7.4. Service fixtures.

Service fixtures shall be provided as required in this Design Criteria (Section IV-C-1) and specified in the drawings.

a. All plumbing service fixtures should be located inside the hood within 12 inches of the hood sash on a common vertical center line and have remote activation handles on the outside of the sash post.
    - Unless otherwise specified, one set of service fixtures, located on one interior side, is sufficient for 3-foot and 4-foot width hoods.
    - 5-foot and 6-foot width hoods should have two sets of service fixtures inside the hood, one set on each side.

b. Gas, air, vacuum service fixtures shall be located inside the hood within 12 inches of the hood sash.
   - Unless otherwise specified, one set of each located on one interior side is sufficient for 3-foot and 4-foot width hoods.
   - 5-foot and 6-foot width hoods require two sets of these supply fixtures, one set on each side.
   - Recommended vertical order of installation: gas at lowest position, air at mid-position, vacuum at highest position.

c. Vertical-discharge water service fixture(s), with vacuum breaker, shall be provided for each cupsink, positioned above to drain directly into it.
d. Cupsinks may be provided if mounted in the countertop:

- Unless otherwise specified, 1 cupsink for the water fixture on one interior side of 3-foot and 4-foot width hoods.
- 5-foot and 6-foot width hoods may have 2 cupsinks, one for each water fixture, inside the hood on each side.

e. Electrical service fixtures shall be combination type, mounted at the lowest point on a hood sash post:
   - Minimum of (2) 120-volt A.C., GFCI-protected outlets per post.

f. GFCI circuits provided within the power panel shall be identified as such on the panel facing.
g. A light switch for interior fixture lamps mounted on an exterior sash post.
h. Interior lamp fixture having twin lamps capable of providing at least 60 foot-candles (f.c.) of illumination as measured across the interior base of the hood.
i. Perchloric acid and special-purpose hoods provided with an explosion-proof lamp fixture (lamp not to exceed 150-watts unless specified by the manufacturer).

6.7.5. Low airflow alarm console.

While the design of the fume hood should maintain face velocity controls to + or – 10%, alarms shall be set at + or – 20%.

a. A factory-mounted safety alarm console shall be recess mounted into the hood facing according to alarm console manufacturer's instructions. (VAV Fume Alarm consoles are field installed and calibrated.)
b. Air velocity sensors, if external, shall be installed and identified per the manufacturer's instructions, and be easily accessible. Static pressure sensors may be used in place of conventional air velocity sensors

provided the institution's appointed Environmental Health and Safety department approves.

c. Console shall have plate-mounted or plastic-adhering operating instructions applied on or next to the console. Digital instructions displayed from the console are also acceptable.
d. Console shall have a digital device calibrated to read average face velocity (applies to conventional air velocity monitors).
e. Console shall have an audible alert with sound pressure intensity of at least 65 decibels.
f. Console shall have an audible and visual indicator to indicate low airflow. The visual indicator shall remain activated if the audible alarm is silenced and until the alarm is reset.
g. Console shall have a circuit test button to verify operation of the audible and visual alarm components.
h. A means of disabling the console alerts shall be provided for maintenance, apparatus assembly, etc.
i. A 6-second delay circuit shall be provided to prevent false alarms when exhaust system is reactivated.
j. If the hood is connected to an energy management system (EMS), the safety alarm function shall be integrated with and monitored by the EMS system. Also, for hoods having power switches on the hood face, or for hoods having a set-back operating mode, the alarm function shall not activate when power is intentionally turned off or set back.
k. A contact closure or local area network device capable of indicating a low airflow condition shall be provided as a means to interface with the building airflow control system.
l. Alarm consoles shall be RoHS compliant.

### 6.7.6. Hood access panels.

a. Hood interior side wall access panels shall be furnished and properly installed.
b. No positive pressure ventilation shall be introduced into the hood behind the plane of the sash.
c. Access to hood utilities should be integrated into the lab design.

### 6.7.7. Hood sash.

Hood sash selection shall be based on anticipated needs and risks of laboratory. See below for sash requirements.

a. The front face of the hood shall have a sash frame constructed of the same material as the fume hood with its window made of flame and shatter-resistant (and non-splintering) transparent material.
b. The sash shall be capable of vertical or horizontal movement to close off the entire front opening.
c. Vertical sashes are the preferred configuration shall move throughout their travel by applying no more than 5 lbs. of force. They must remain stationary when force is removed.
d. Horizontal sashes, if used, shall consist of at least two panels, movable throughout their travel by applying no more than 5 lbs. of force and be 12 to 14 inches in width. They must remain stationary when force is removed.
e. Combination sashes vertical and horizontal), if used, shall meet the requirements for each as noted above.
f. Factory-installed sash stops shall be provided and installed 18 inches above the working surface, with easy release to open the sash further for set-up work.
g. Automatic sash closures may be considered for all new chemical fume hoods connected to VAV systems. Consideration should be given to the flexibility of closure settings.
h. All non-automatic sash doors will be equipped with a sash counterbalance system. These systems can consist of a cable & pulley OR chain & sprocket.

6.7.8. Hood airfoil.

a. Hood airfoil shall be located approximately 1 inch above the hood working surface, securely connected per manufacturer's instructions.
b. Airfoil shall provide the bottom stop for the hood sash.

6.7.9. Hood baffle openings.

a. Interior exhaust openings shall be provided nearly full width across the bottom, center, and top rear of the hood.
b. Opening size shall range from 1 ½- to 4-inches.
c. Baffles may be installed over the openings to close them off as desired. If installed, baffles must be mechanically or electrically activated to open or close from the exterior hood face. Interior adjustment knobs or levers are not permitted.

6.7.10. Hood identification nameplates.

a. Nameplates are required for perchloric acid hoods, reading: “Only reactions with perchloric acid are permitted in this fume hood.”

**Note**: Perchloric acid hoods should not be used for non-perchloric acid reactions, because organic material may violently react with perchloric acid if not routinely washed down.

b. Nameplates are recommended for general purpose, radiation, and special purpose hoods, for general purpose and radiation hoods, nameplates should state “Do not use perchloric acid within hood”.
c. Sign lettering size recommended for hood type is at least 1/2-inch height, with text lettering at least ¼-inch height.

6.7.11. Operating instructions.

Manufacturer’s hood operating instructions shall be provided.

6.7.12. Hood filter units.

a. When hood duct filtration is required for specific contaminants, filtration units shall be located on the building roof or in an otherwise safe and easily accessible area for filter changes.
b. Inclined manometers, or equivalent devices, shall be provided to indicate filter loading and resulting pressure increases within the duct so filters may be changed as needed.
c. Standard operating procedures must be established for filter changes and other maintenance required. All institutions must perform hazard assessments.

## 6.8. Fume Hood Work Surface Materials

Recommended fume hood interior and work surfaces shall be:

- General purpose hoods: Epoxy, Trespa, or stainless steel
- Special purpose, perchloric acid and radiation hoods: shall be stainless steel

Exterior surfaces should be chemical-resistant and color-compatible with lab walls and furnishings.

## 6.9. Fume Hood Installation

6.9.1. Hood superstructure.

Chemical fume hoods shall be installed in accordance with requirements in this section, with hood superstructures secured to countertops.

6.9.2. Equipment.

a. Factory-installed permanent sash stops shall be incorporated into all new laboratory chemical fume hoods, incorporated with a low airflow alarm system as detailed elsewhere in this document.
b. Lighting fixtures within the hood shall be furnished and installed. General and special purpose and radiation hoods shall have fluorescent or LED lamp fixtures (2 lamps per fixture) rated to provide at least 60-foot candles lighting intensity measured across the base of the hood. Perchloric acid hoods shall have an explosion-proof rated lamp fixture provided with a 150-watt bulb (or equivalent lower wattage providing specified illumination).
c. Static pressure sensors for the low airflow safety alarm console (if used), shall be provided, attached to the alarm console and pre-set into the interface connection.

6.9.3. Fume hood exhaust ducts.

a. Exhaust duct materials shall be selected, sized, and installed based on sound engineering principles. Selected duct materials shall be compatible with the intended uses for the hoods, compliant with existing building/fire code, and appropriately durable. All standard fume hood exhaust ducts shall be constructed with 316 at a minimum up to the manifold if in a manifolded system.
b. Roof penetrations for ductwork shall be water-proof and weather-tight.
c. Exhaust duct seams shall be welded and ground smooth, or otherwise joined using methods and materials providing equivalent leak-proof containment. If duct seams are not to be welded, submittals shall be provided explaining the method and materials to be used. Spiral ductwork is prohibited on all chemical fume hoods.
d. A minimum of two (2) duct diameters (length) of straight ductwork shall be provided ahead of the exhaust fan inlet to minimize system air turbulence.
e. Ducting from individual chemical fume hoods shall be installed vertically whenever possible. When horizontal runs are required runs shall not

exceed 10ft in total length and shall be sloped back to the fume hood at a minimum of ¼-inch per foot.

f. Duct turns from fume hood to exhaust fan may be smooth radius or gored, limited to 3 turns. Sharp-angle changes of direction are prohibited.

g. For hoods installed on exterior laboratory walls, offsets are permitted at the smallest angle possible (not to exceed 45º) to connect the duct to the roof fan or manifold system.

h. Duct damper and valve units shall be located for safe access, in accordance with regulatory standards, for adjustments and maintenance.

i. The duct interface section furnished as an extension above the hood outlet, shall be made of approved material having smooth connection joints between the hood and exhaust duct. The interface and all flanged gaskets, shall be installed, braced, and properly connected.

j. Exhaust duct (above interface connection) shall be furnished and properly connected to the exhaust fan.

k. Perchloric acid hoods shall have a duct and interface wash-down system furnished, installed, labeled, properly connected to drain, and tested to be operational. An isometric drawing showing the piping installation, including stop and drain valves, shall be provided. Proper plumbing connections include connecting the system wash-down lines to the activation handle.

l. Perchloric acid and special-purpose chemical fume hoods shall be separately exhausted, and not combined with other fume hood exhaust systems.

m. Hood outlet exhaust flanges shall be of the size needed to provide required airflow through the duct. They shall be pre-drilled for bolting to the ductwork.

n. Outlet exhaust flanges shall be made of materials deemed appropriate for intended use and installed to minimize turbulence in the outlet or duct.

o. Ductwork and exhaust stacks shall be sized for acceptable exhaust velocity between 3000 to 4000 feet per minute for single chemical fume hood systems, measured at the top of the exhaust stack. Velocities maybe reduced when a detailed wind wake study is conducted to support reduction.

p. Exhaust stacks shall be designed and located in accordance with ANSI / AIHA Z9.5 to prevent re-entrainment of contaminants back into the building. In high density situations, a computational fluid dynamics (CFD) analysis may be required.

q. Exhaust stack height shall be higher than the top of the nearest intake and at least 10 feet above the roof plain, adjacent structure or architectural barrier, where located. Aesthetic considerations are not grounds for variances from this requirement. Architectural barriers

placed to conceal the stack for aesthetic reasons may be acceptable, provided the exhaust flow is not impeded.

r. Stacks shall be braced or guy-wired for stability.

s. Rain caps and other fixtures that may impede exhaust stack airflow are prohibited.

t. Each duct shall be permanently labeled, where accessible, above the laboratory ceiling, in a penthouse or on the roof, as to the location of the fume hood it serves (listing room number) for maintenance efficiency and to assure the correct hood is selected. Labels must be easily read from the access point.

u. Exhaust fan units shall be permanently labeled to identify the fume hood they serve.

    i. Exhaust fans and motors for each hood system shall be designed to accommodate at least 10% extra capacity to compensate for normal system loss.

    ii. Fan motors shall not operate at design capacity exceeding 90% of motor nameplate horsepower.

6.9.4. Hood exhaust fan system (non-manifold).

a. Fume hood exhaust fan and motor drive unit shall be located on the building rooftop or in a dedicated mechanical system penthouse, have a weather-protected exterior, and be designed and placed to be readily accessible for visual inspection and maintenance.

b. All moving parts shall be properly guarded.

6.9.5. Special controls for VAV hoods.

a. Airflow sensors and pressure independent quick response valves (less than 3 seconds) shall be installed in the exhaust duct, such that electronic controls are protected from the elements, to maintain face velocity and to prevent backflow or air volume fluctuations.

b. Provide closed loop feedback control that regulates airflow volumes to maintain a constant face velocity through the open sash.

c. Provide air volume metering devices or flow measurement devices that are 5% through the range of the varying volume, or face velocity measurement.

d. Face velocity shall be directly measured or calculated based on exhaust air CFM divided by sensed open area of the sash.

e. Where VAV hood are used, fume hood zone presence sensors may be used to reduce face velocity when the hood are unoccupied, providing that the hood will maintain containment at the reduced face velocity.

Unoccupied FPM settings shall be based on casework manufactures recommendations and field testing.

## 6.10. Fume Hood Performance

### 6.10.1. Design performance.

Chemical fume hoods shall be designed to be an integral part of the building HVAC system so that, when connected to an exhaust system, will operate in a safe, efficient manner, within acceptable airflow tolerances as specified in Section V-B-1 (*Fume Hood Airflow Requirements).*

### 6.10.2. Hood performance documentation.

Documentation of hood performance, capture efficiency, and containment effectiveness shall be provided to the institution prior to acceptance of the proposed design strategy. This documentation shall attest that hood performance is adequate for owner's intended use. The fume hood certifier shall affix a label to face of hood attesting to hood performance.

### 6.10.3. Hood sound level.

Hood sound level, when measured at approximately ear level within one foot of the front of the hood, with sash open 18 inches, shall not exceed 63 decibels (dBA). Design specified noise level for dedicated fan units shall not exceed 60 dBA in the duct at more than 5 feet from the fan inlet.

### 6.10.4. Low airflow alarm activation.

Low airflow alarm console shall activate and read out according to the design criteria specified above in this document.

### 6.10.5. Control valve technology performance documentation.

VAV hood installations shall have documentation certifying the performance of control valve technology. Note: Plans for use of this technology shall be included as part of the preliminary design documents. This shall be a successful, proven technology with a demonstrated track record of 3 years or more. The performance of these valves shall also be checked after installation to verify performance.

### 6.10.6. Hood exhaust discharge velocity.

a. Hood exhaust for both constant volume and VAV hoods shall meet the discharge velocity requirements of ANSI/AIHA Z9.5 (most current version).
b. Up to 4000 FPM are acceptable for discharge velocity for single fan/chemical fume hood system, however, use good engineering practices.

# 6.11. Laboratory HVAC and Fume Hood System Test and Balance

## 6.11.1. Installation coordination.

Vendor's or manufacturer's representative are responsible to coordinate required installation and testing of air handling equipment and fume hood systems.

## 6.11.2. Test and balance and fume hood certification requirements.

a. Each new or modified laboratory ventilation system and/or fume hood shall be tested and balanced based upon good engineering practices. Each fume hood shall be certified according to the latest ASHRAE 110 method to assure it was installed in accordance with manufacturer instructions and DC requirements.
b. While in operation, each hood system shall be tested and balanced to provide specified airflow rates and volumes, with all single air measurements testing to within +/- 20 (fpm) for traditional and +/-10 (fpm) for high performance of the average. Final adjustments needed shall be made before occupancy.
c. Airflow testing, with fume hood sash set at sash stops (18 inches open), shall be verified as set at **100 feet per minute** (fpm) for conventional chemical fume hoods and at least 60 FPM for high performance (Berkeley 2) chemical fume hoods. NOTE: Other fume hood designs which maintain safety and appropriate capture efficiency at lower face velocities may be considered on a project-by-project basis.
d. Low airflow alarm console, properly set, shall be verified as activating when airflow drops more than 10% below the lowest full-open sash face velocity at which the fume hood is approved (60 fpm (high performance) or 100 fpm (conventional)).
e. All control and operating equipment shall be verified as performing within required specifications.
f. Fume hood operating and maintenance instructions (from the manufacturer) shall be provided and/or affixed to the fume hood.
g. A copy of the T&B test report shall be furnished as part of final project documentation.
h. All installation and performance deficiencies shall be addressed and corrected by the contractor before occupancy. **Note**: Airflow performance shall be verified according to the laboratory HVAC system test and balance report

## 6.11.3. Annual Hood Verification (GUIDANCE FOR INSTITUTIONS)

Each USG Institution shall provide annual verification of all chemical fume hoods in use by suitable quantitative (e.g. airflow) and qualitative (e.g. visual challenge) testing in the as used (AU) condition, consistent with the latest ASHRAE 110 method. Some adaptation may be required depending on set-backs, sensing methods, etc. Institutions are encouraged to use third party testing firms that specialize in this type of commissioning/testing. Testing firms should be qualified and provide proof of competency, to be determined by the institution. As a general rule, these specialized testing firms should have at least 50% gross revenue associated with testing chemical fume and/or biological safety cabinets.

Institutions should strongly consider testing all high performance hood systems to the full ASHRAE 110 testing requirements every 5 years.

## 6.12. Exhaust Manifold Systems

### 6.12.1. Design requirements.

a. Exhaust manifold systems shall be designed to minimize the number of required fan units needed. Manifold fan systems shall be designed with N+1 redundancy.
b. Exhaust manifold systems shall be provided with fan systems capable of powering up within 3 seconds and continue exhausting air through the system at the prescribed rate, should one fan motor fail.
c. All moving parts shall be properly guarded.
d. Manifold system dampers and control valves shall be accessible for routine maintenance and adjustment.
e. Individual duct connectors into a manifold plenum shall be permanently labeled as to the fume hood they serve so service and airflow adjustments are made to the right hood.
f. Ducts exhausting highly hazardous materials shall be appropriately labeled.
g. Exhaust fans and motors shall be designed to accommodate at least 10% extra capacity to compensate for normal system loss and for possible future expansion. Their maximum design load shall not exceed 90% of motor nameplate horsepower.
h. The manifold (itself) is not required to be constructed of 316, however, for any portion of the manifolded system not diluted with general exhaust or with adequate hood diversity shall be 316.

### 6.12.2. Manifold exhaust ducts.

a. Manifold duct systems must be designed and properly sized to accommodate all duct connections, minimizing internal air turbulence throughout the system.
b. Branch connections to a manifold duct system shall be limited to 3 turns (smooth radius or gored elbows are acceptable), each not exceeding a 90º angle.
c. 45º take-off connectors shall connect branch ducts to a manifold to minimize air entry turbulence at the manifold.
d. Branch connections to a larger size duct shall be offset from one another and appropriately spaced to minimize air turbulence.
e. Extra manifold connections shall be provided based on anticipated program needs.
f. Exhaust duct manifolds may be routed horizontally above ceilings to provide appropriate connection points for chemical fume hoods in different locations on the same floor prior to connecting to a vertical duct riser. NOTE: Exhaust ducts from other equipment or laboratory apparatus shall only be permitted to connect to the manifold duct if the institution engineering and Environmental Health and Safety departments approve, and if pre-design analysis demonstrates that the system will function properly and safely.
g. All inaccessible ductwork leading to the manifold shall be constructed of 316 stainless steel and the joints must welded and grind smooth (interior). The manifold can be constructed with alternate materials of construction, according to best engineering practice.

6.12.3. Exhaust manifold system considerations.

a. Fume hood exhaust manifold systems are approved for use when the design professional deems this as the best method.
b. Perchloric acid and special-purpose hoods must have their own duct/fan system, or dedicated and labeled manifold system.
c. Manifold systems shall include sufficient redundancy to maintain continuous negative pressure in lab chemical fume hoods and ducts, as well as provide sufficient exhaust velocity from exhaust ducts. This will include, as a minimum:
    i. A generator shall be provided to maintain 25% fume hood exhaust capacity in the event of a power failure. Design consideration shall be made to assure safe lab pressurization. All such systems shall be commissioned. Where alternate means of reliable power exist, institutions may submit to the BOR for a variance.
    ii. Airflow sensors and quick-response valves (less than 3 seconds) or through-the-wall airflow/sash position sensitive

valves in each hood exhaust duct to prevent back-flow or significant air volume fluctuations.

d. One or more spare exhaust fan units (N+1) shall be provided, capable of handling continuous required exhaust volume if one fan unit fails or is down for repair.
e. Manifolded fume hood exhaust ductwork shall be designed to withstand the maximum pressure that can be generated by the fan. Duct reinforcement and construction methods must exceed the fan's capability or a negative pressure release device calibrated for the maximum fan pressure shall be provided.
f. Laboratory high plume dilution fans that use direct drive assemblies preferred.

# 7. OTHER LABORATORY EQUIPMENT

## 7.1. Biological Safety Cabinets

The type, intended use and location of BSCs, in institutions with a Biosafety Committee and a Biosafety Officer, shall be approved by the Biosafety Officer prior to specification, purchase and installation.

Biological safety cabinets (BSC), require appropriate design and installation criteria. Those purchased and installed at USG institutions shall be in compliance with that criteria, as outlined in National Sanitation Foundation (NSF) International Standard #49 (most current version), Biohazard Cabinetry and "Biosafety in Microbiological and Biomedical Laboratories", U.S. Dept. of Health & Human Services (most current version).

Careful selection of BSC type is essential, and selection of non-ducted BSC's should be made when appropriate.

## 7.2. BSC Descriptions

### 7.2.1. Design protection.

Biological safety cabinets (BSCs) are designed to protect the operator, and the laboratory environment from exposure to infectious aerosols that may be generated when manipulating materials containing infectious agents such as primary cultures, stocks and diagnostic specimens. Class II and above BSCs also provide product protection through the use of downward HEPA filtered laminar air flow onto the work surface.

The following information was adapted from the National Sanitation Foundation (NSF) Standard 49, the World Health Organization (WHO) "Laboratory Biosafety Manual", and the Centers for Disease Control and Prevention (CDC), and National Institutes of Health (NIH) joint publication, "Primary Containment for Biohazards: Selection, Installation and Use of Biological Safety Cabinets".

7.2.2. Cabinetry types and classes.

BSCs, when properly used, have been shown to be highly effective in reducing laboratory-acquired infections and cross-contaminations of cultures as well as protecting the environment.

The primary means used to accomplish this, and one of the major differences between a BSC and a chemical fume hood, is by utilizing high-efficiency particulate (HEPA) filters. The HEPA filter traps 99.97% of particles of 0.3 µm in diameter and 99.99% of particles of greater or smaller sizes. This enables the HEPA filter to effectively trap all known infectious agents and ensure that only microbe-free exhaust air is discharged from the cabinet.

There are three classes of BSCs, which are discussed below. Please note that horizontal and vertical outflow cabinets (i.e. clean-air work stations) are not BSCs and should not be used as such.

a. **Class I BSC**: A ventilated cabinet for personnel and environmental protection, having an un-recirculated inward airflow (75 ft/min) away from the operator that exhausts all air to the atmosphere after filtration through a HEPA filter. Class I cabinets are suitable for work where no product protection is required.
b. **Class II BSC**: A ventilated cabinet with inward airflow for personnel protection, downward HEPA filtered laminar airflow for product protection, and HEPA filtered exhausted air for environmental protection.

There are four types of Class II BSCs:

***Type A1*** – Maintains a minimum average inflow velocity of 75 ft/min with HEPA filtered downflow air that is a portion of the mixed downflow and inflow air from a common plenum. Approximately 70% of the air recirculates through the supply HEPA filter back into the cabinet's work zone with the remaining 30% passing through the exhaust HEPA filter into the room or the outside through a thimble connection. Contaminated plenums are under positive. Type A1 cabinets are not suitable for work with volatile toxic chemicals and volatile radionuclides.

***Type A2*** – Maintains a minimum average inflow velocity of 100 ft/min with HEPA filtered downflow air that is a portion of the mixed downflow and inflow air from a common plenum. Approximately 70% of the air recirculates through the supply HEPA filter back into the cabinet's work zone with the remaining 30% passing through the exhaust HEPA filter into the room or the outside through a thimble connection. All biologically contaminated ducts and plenums are under negative pressure or surrounded by negative pressure ducts and plenums. Type A2 cabinets are suitable for work with minute quantities of volatile toxic chemicals and trace amounts of radionuclides when air is exhausted through properly functioning exhaust canopies (i.e. thimble connection).

***Type B1*** – Maintains a minimum average inflow velocity of 100 ft/min with HEPA filtered downflow air composed largely of uncontaminated recirculated inflow air. Approximately 40% of the air recirculates through the supply HEPA filter back into the cabinet's work zone with the remaining 60% passing through the exhaust HEPA filter to the outside through a dedicated duct. All biologically contaminated ducts and plenums are under negative pressure or surrounded by negative pressure ducts and plenums. Type B1 cabinets are suitable for work

with minute quantities of volatile toxic chemicals and tracer amounts of radionuclides.

***Type B2***– Maintains a minimum average inflow velocity of 100 ft/min with HEPA filtered downflow air drawn from the laboratory or the outside air. All inflow and downflow air is exhausted to the outside after filtration through a HEPA filter without recirculation into the cabinet's work zone or return to the laboratory. All biologically contaminated ducts and plenums are under negative pressure or surrounded by negative pressure ducts and plenums. Type B2 cabinets are suitable for work with volatile toxic chemicals and volatile radionuclides.

c. Class III BSC: A totally enclosed, ventilated cabinet of leak-tight construction (a.k.a. "Glovebox"). Activities inside the cabinet are conducted through attached rubber gloves. The cabinet is maintained under negative air pressure of at least 0.5 inches water gauge (120 Pa). Downflow air is drawn into the cabinet through HEPA filters, and exhaust air is treated with double HEPA filtration or by HEPA filtration and incineration.

| New NSF Classification, Adopted 2002 | Previous NSF Classification | General Description |
|---|---|---|
| A1 | Class II, Type A | • 70% air recirculated; 30% exhausted from a common plenum to the room;<br>• 75FPM intake;<br>• may have biologically contaminated positive pressure plenum |
| A2 | Class II, Type A/B3 | • 70% air recirculated; 30% exhausted from a common plenum to the room;<br>• 100FPM intake;<br>• biologically contaminated plenum under negative pressure or surrounded by negative pressure |
| A2 | Class II, Type B3 | • 70% air recirculated; 30% exhausted from a common plenum to a facility exhaust system;<br>• 100FPM intake;<br>• biologically contaminated plenum under negative pressure or surrounded by negative pressure |
| B1 | Class II, Type B1 | • 40% air recirculated; 60% exhausted from cabinet;<br>• exhaust air pulled through dedicated exhaust duct into facility exhaust system;<br>• 100FPM intake<br>• all biologically contaminated plenums are negative to the room or surrounded by negative pressure plenums |
| B2 | Class II, Type B2 | • 0% air recirculated; 100% exhausted from cabinet<br>• exhaust air pulled through dedicated exhaust duct into facility exhaust system;<br>• 100FPM intake<br>• all ducts and plenums are under negative pressure<br>• all contaminated ducts are under negative pressure or surrounded by directly exhausted negative pressure ducts or plenums |

## 7.3. BSC Considerations

### 7.3.1. Selection.

A BSC should be selected based on risk assessment and primarily in accordance with the type of protection needed: product protection; personnel protection against Risk Group 1-4 microorganisms; personnel protection against exposure to radionuclides and volatile toxic chemicals; or a combination of these.

### 7.3.2. Location.

The velocity of air flowing through the front opening into a BSC varies between 75 and 100 ft/min, depending on the Class and Type of cabinet. At this range of airflow velocity, the integrity of the directional air inflow is fragile and can be easily disrupted by air currents generated by people walking close to the BSC, air supply vents, and opening and shutting doors. BSC shall not be installed in rooms with windows that open and near doors.

Ideally, BSCs should be situated in a location remote from traffic and potentially disturbing air currents. A clearance of at least 6 inches is needed on each side of a cabinet for service fixture access. When possible, a 1-foot clearance should be provided behind and on each side of the BSC to allow easy access for maintenance. A clearance of 18 inches above the BSC may be required to provide for accurate air velocity measurements across the exhaust HEPA filter and for exhaust HEPA filter changes.

7.3.3. Service fixtures installation and clearance.

Service fixtures required shall be installed properly and perform acceptably. These require a minimum of 6 inches clearance on each side of a cabinet for maintenance access. Overhead clearance for exhaust air discharge should be at least 18 inches from the ceiling. Natural gas is prohibited from being connected to all BSCs except for Class II type B2.

7.3.4. Unwrapping of cabinets.

New cabinets shall not be unwrapped until dust-creating activities are completed within the laboratory.

7.3.5. Initial certification of BSC.

Initial certification of cabinet performance shall be performed by an accredited certifier before cabinet use.

7.3.6. Certification parameters.

a. The functional operation and integrity of each BSC should be certified to NSF 49 specifications at the time of installation, after relocation, after repair and annually thereafter by qualified technicians. As a general rule, these specialized testing firms should have at least 50% gross revenue associated with testing chemical fume and/or biological safety cabinets.
b. Evaluation of BSC containment effectiveness includes tests for:

    i. Cabinet integrity
    ii. HEPA filter leaks
    iii. Down-flow velocity profile
    iv. Face velocity
    v. Negative pressure / ventilation rate
    vi. Air-flow smoke pattern
    vii. Alarms
    viii. Interlocks

c. Optional tests which may also be conducted include:

    i. Electrical leaks
    ii. Lighting intensity
    iii. Ultraviolet light intensity
    iv. Noise level

v. Vibration

7.3.7. Operation of BSC.

Most BSCs are designed to allow operation 24 hours a day.

a. Class II A1 and A2 BSCs exhausting to the room or connected by exhaust canopies (i.e. thimble connections) can be turned off when not in use.
b. Class II B1 and B2 BSCs, which have hard-ducted installations exhausting to the exterior, must have airflow through them at all times to help maintain room air balance.

7.3.8. Relocation and Repair of BSCs

a. Decontamination: BSCs that have been used for work involving infectious or potentially infectious materials must be decontaminated before being relocated, internal repair work conducted or HEPA filters are changed. A risk assessment considering the agents manipulated within the BSC must be performed to determine the method of gas of vapor decontamination. Common methods of decontamination include vaporized hydrogen peroxide, chlorine dioxide and formaldehyde gas. Due to the hazards associated with these methods, decontamination must be performed by a trained and qualified individual.
b. Recertification: After the decontaminated BSC has been relocated or repaired certification must be completed to issue proper functioning of the unit.

7.3.9. Laminar Flow Cabinet

a. A laminar flow cabinet (tissue culture hood) is an enclosed bench designed to prevent the contamination of biological samples. The laminar flow cabinet draws air through a HEPA filter and blows that air onto the user. The cabinet does not provide user protection and its use and placement should be carefully reviewed by Environmental Health and Safety in conjunction with the users.

## 7.4. Emergency Safety Showers and Eyewash Stations

All emergency safety showers and eyewash stations shall meet the requirements of the latest ANSI Z358.1 standard, with the following exceptions and clarifications:

7.4.1. Location of emergency safety showers.

All primary emergency safety showers shall be properly installed and plumbed, within a 10-second walking time from the location of any hazard within the laboratory area. For general laboratories, emergency safety showers may be permitted in central locations (e.g. hallways).

7.4.2. Laboratory preparation rooms.

All preparation laboratory rooms with chemical storage in academic laboratories shall at least one permanently installed emergency shower and eyewash station.

7.4.3. Research laboratories.

Research laboratories involving chemical or hazardous processes should be equipped with at least 1 eyewash station per 350 square feet of laboratory space and 1 emergency safety shower within 10 seconds walking, provided the path of travel does not exceed one outwardly opening door from the laboratory space. Additional eyewash units may be required based on a hazardous assessment provided by Institutional Environmental Health and Safety Officer/Coordinator.

7.4.4. Teaching laboratories.

Teaching laboratories with wet chemicals or other hazardous operations shall have at least 2 approved eyewash stations per 24 seats.

7.4.5. Floor drains.

Floor drains are permitted (institution option), please refer to IV.C.9.

7.4.6. Testing.

a. Per the ANSI standard Institutions should flush emergency eyewash stations weekly.
b. Emergency safety showers should be tested at least annually (see ANSI Z358.1 for guidance). Showers should be tested for flow, clarity and temperature.

7.4.7. Modesty screens.

Consideration shall be made for the installation of modesty screen in locations where privacy cannot otherwise be achieved.

7.4.8. Water tempering.

Institutions can exercise individual discretion on whether or not to temper water for eyewash and emergency safety showers as required by the ANZI Z358.1-2014 standard.

## 7.5. Flammable Liquids Storage Cabinets

Flammable liquid storage cabinets shall be provided for laboratories where more than 10 gallons of flammable or combustible liquids are likely to be stored, handled, or used. An appropriate number of cabinets should be provided, of appropriate size, to meet the anticipated needs and allowable load of flammable and combustible liquids for the laboratory fire area.

### 7.5.1. Cabinet rating.

Installed or provided cabinets shall be properly labeled, and be Underwriters Laboratories (UL), and Factory Mutual (FM) approved.

### 7.5.2. Cabinet basin.

Cabinet shelf must have a retention basin in bottom of cabinet to contain leakages.

### 7.5.3. Cabinet doors.

Cabinets shall have positive-latching, self-closing doors.

### 7.5.4. Cabinet venting.

a. Un-vented cabinets may be installed/used. However, depending on the types and amounts of chemicals stored, laboratory air quality may be adversely impacted. Vent plugs provided by the manufacturer must be in place in all un-vented cabinets.
b. Vented cabinets shall be directly vented outdoors in a manner that does not compromise cabinet fire rating and performance and in a manner which does not allow vapors to re-enter the building.
c. Manifolding vents of multiple storage cabinets is prohibited.

## 7.6. Corrosives Storage Cabinets

Corrosives cabinets meeting criteria in this section shall be provided in sufficient numbers for storage of acids and bases planned for use.

#### 7.6.1. Cabinet construction.

Cabinets shall be made of non-corroding materials.

#### 7.6.2. Secondary containment.

Cabinets shall have catch pans or tubs to retain liquid spills.

#### 7.6.3. Labeling.

Each cabinet shall be individually labeled for storage of either acids or bases (not both).

## 7.7. Gas Cylinders Storage

#### 7.7.1. Storage area requirements.

a. Cylinders storage rooms and closets shall be prominently identified as to the type gas contained.
b. Laboratories using compressed gases having an NFPA health hazard rating of 3 or 4 shall have a continuous mechanically-vented storage area for these gases. Continuous venting shall also be provided for pyrophoric gases and those (other than compressed air) having no physiological warning properties, regardless of health hazard rating.
c. Programmable oxygen level and toxic gas sensing devices shall be provided for each gas storage and use area as specified by code. These devices shall be capable of alarming to warn area occupants of a gas venting episode, or if the oxygen level in the area is diminished (e.g. cryogenic gas storage). The warning provided shall be visual and audibly distinguishable, to be heard over other noise sources. Where possible, the alarm should be centrally monitored at a remote location.

#### 7.7.2. Securing of cylinders.

All gas cylinders shall be properly restrained per guidance from the Compressed Gas Association. Cylinder connection closets are recommended for compatible compressed gases.

#### 7.7.3. Marking of connectors and lines.

Where permanent connection hoses and lines are provided for cylinder gases, they shall be marked to identify the gas they contain and the direction of gas flow.

## 7.8. Emergency Backup

a. Each institution must evaluate the need for emergency backup circuits in laboratories, especially in research areas which support specialized equipment (e.g. cryogenic freezers) not already covered in building and fire codes.
b. Where significant heat load will accumulate if ventilation is off, backup power should also provide cooling, or at least ventilation, to hot areas (e.g. data centers or freezer warehouses).
c. If a mission critical, process water cooling loop is installed, emergency power should be supplied to the loop pump in case of power failure or cooling plant failure. While water may not be chilled, its circulation may be adequate to prevent damage to critical equipment.
d. Consideration should be given to emergency power for projected research requirements within the facility, as feasible.
e. All emergency power generators will be natural gas. Variance requests for diesel will be considered through the variance process.
f. All generator capacity must be determined by considering fire and life safety, air quality and building pressurization. All emergency power generator systems must be commissioned and tested.

## APPENDIX A: Renovation & New Project Review Checklist – Laboratory Building

This is an USG internal document to facilitate review, by EHS and Facilities Planning staff, of renovation or new laboratory facilities. The checklist is consistent with BOR policies, current standards, best practices, and government regulations. This checklist was developed to provide guidance and facilitate dialogue during the design phase, rather than prescribe requirements. The checklist is not exhaustive and can be augmented as necessary, based on project-specific condition, needs, and revisions of governing requirements. **(This document was developed by Stephen Ndiritu, CIH, CSP, of Kennesaw State University.)**
**Please be advised that codes, standards, and other guidance may have changed since this document was created.**

## FACILITY INFORMATION

| | | | |
|---|---|---|---|
| Project Name | | | |
| Project Description | | | |
| Project Type | ☐New Construction ☐Renovation ☐Demolition | | |
| Review Phase | ☐Schematic ☐Preliminary ☐Working Drawings ☐Pre-Construction ☐Final | | |
| Project Manager | | Tel: | |
| Project Start Date | | Project End Date | |

| | | | |
|---|---|---|---|
| EHS | | | |
| Name | | Title | |
| Signature | | Date | |

| Description | References | ☐Yes ☐No ☐NA | Notes |
|---|---|---|---|
| LABORATORY VENTILATION & CHEMICAL FUME HOODS | | | |
| All laboratory spaces are mechanically ventilated with all lab rooms exhausting 100% to the outside – no recirculation of fume hood exhaust | *Prudent Practices* | ☐Yes ☐No ☐NA | |
| No installation of ductless fume hood without prior review and approval by EHS on a case-by-case basis. | *ANSI Z9.5* Prudent Practice | ☐Yes ☐No ☐NA | |
| Chemical fume hoods are UL certified and installing contractor has demonstrated proper operation of the chemical fume hoods using ANSI/ASHRAE 110 test method before closeout. | BOR | ☐Yes ☐No ☐NA | |
| Flexible local exhaust devices (“snorkels” or “elephant trunks”) designed to adequately control exposures to hazardous chemicals from lab equipment such as gas chromatographs, vacuum pumps, atomic absorption, or other equipment that can produce potentially hazardous air pollutants. | *ACGIH, Ventilation Manual* | ☐Yes ☐No ☐NA | |
| Necessary acoustic treatment is provided to avoid excessive noise levels in laboratories. Fume hood sound level at the sash does not exceed **63 dB.** | *ANSI Z9.5 5.1.3* *Prudent Practices* | ☐Yes ☐No ☐NA | |

| | | |
|---|---|---|
| Chemical fume hoods, and other laboratory exhaust ventilation are designed in accordance with ANSI/AIHA Z9.5, and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice*. | ANSI/AIHA Z9.5<br>ACGIH's Ventilation Manual | ☐Yes ☐No ☐NA |
| Hoods are located away from doors or activities that may produce air currents or turbulence. | *BOR*<br>*Prudent Practices* | ☐Yes ☐No ☐NA |
| Chemical fume hoods are not be located adjacent to an emergency exit unless a second exit is provided. | *BOR*<br>*NFPA 45,* | ☐Yes ☐No ☐NA |
| Fume hood superstructures are secured to countertop cabinet. | *BOR* | ☐Yes ☐No ☐NA |
| Controls for the fume hood utilities - electrical, air, water, etc. are located external to the hood and easily accessible to users. | *ANSI Z9.5*<br>*NFPA 45* | ☐Yes ☐No ☐NA |
| Chemical fume hoods 5 feet or wider have service fixtures one on each side. | *BOR* | ☐Yes ☐No ☐NA |
| Fume hood service fixtures are on a common vertical center line. | *BOR* | ☐Yes ☐No ☐NA |
| Fume hood water service fixtures are located directly over cup sinks. | *BOR* | ☐Yes ☐No ☐NA |
| Fume hood light fixture has twin lamps and is properly installed and secured. | *BOR* | ☐Yes ☐No ☐NA |
| Fume hood light fixture has a switch on the hood face and works properly. | *BOR* | ☐Yes ☐No ☐NA |
| Fume hood work surface is recessed at least 3/8 inch below the front edge, sides and back to contain spill. | *ANSI Z9.5*<br>*BOR* | ☐Yes ☐No ☐NA |
| Fume hood airfoil is secured to hood structure. | *BOR* | ☐Yes ☐No ☐NA |
| Fume hood baffles (if supplied) open and close from the hood exterior. | *BOR* | ☐Yes ☐No ☐NA |
| Fume hood sash stops are installed and set at 18 inches from the work surface. | *BOR* | ☐Yes ☐No ☐NA |
| Fume hood sashes move up and down easily and stay where stopped. | *BOR* | ☐Yes ☐No ☐NA |
| Fume hood nameplate is provided, meeting criteria for perchloric acid hoods. | BOR | ☐Yes ☐No ☐NA |
| Sufficient exhaust air is provided to assure the removal of hazardous airborne materials. | *Prudent Practices* | ☐Yes ☐No ☐NA |
| Chemical fume hoods are designed to provide average face velocity of **100 fpm** during normal operations, with sash open at 18" above work surface". | *BOR* | ☐Yes ☐No ☐NA |
| Sufficient airflow velocity provided in each duct to prevent settlement of liquid, condensates and solids in the ducts. | *ACGIH, Ventilation Manual* | ☐Yes ☐No ☐NA |
| Chemical fume hoods are equipped with a both audible and visual flow alarms to alert users to high - and low exhaust flow. | *BOR*<br>*ANSI Z9. 5*<br>*NFPA 45,* | ☐Yes ☐No ☐NA |
| Fume hood low airflow alarm/indicators are working and properly calibrated. | *BOR* | ☐Yes ☐No ☐NA |
| The hood's low airflow alarm activates if exhaust airflow falls below 80 fpm. | BOR | ☐Yes ☐No ☐NA |

| | | |
|---|---|---|
| Fume hood low airflow alarm activates when sash opening exceeds 18 inches. | BOR | ☐Yes ☐No ☐NA |
| Fume hood low airflow alarm audible signal is mutable during alarm sequence. | BOR | ☐Yes ☐No ☐NA |
| Laboratory hoods **DO NOT** have a user-controlled on/off switch. Exhaust fans shall run continuously without direct local control from laboratories. | *ANSI Z9. 5*<br>*Prudent Practices.* | ☐Yes ☐No ☐NA |
| Hoods are provided with user accessible emergency switch that allows the hood exhaust volume to be switched to a maximum exhaust airflow when necessary, e.g. in the event of a spill. | *ANSI Z9.5*<br>*NFPA 45* | ☐Yes ☐No ☐NA |
| Chemical fume hoods have operating instructions/low airflow alarm instructions. | BOR<br>Prudent Practices | ☐Yes ☐No ☐NA |
| Fire dampers or fire sprinklers are not installed in chemical hood exhaust system manifolds. | *ANSI Z9.5*<br>*NFPA 45* | ☐Yes ☐No ☐NA |
| Fume hood exhaust fans will not be shut down automatically when a smoke-alert signal is detected in the supply air system. | *NFPA 45* | ☐Yes ☐No ☐NA |
| Provision(s) to initiate emergency notification and initiate the chemical fume hoods emergency operation mode are in place. | NFPA 45 | ☐Yes ☐No ☐NA |
| Losses of power will not change or affect any of the control system's set points, calibration settings, or emergency status – no need for manual intervention. | ANSI/Z9.5 | ☐Yes ☐No ☐NA |
| Laboratories have fully integrated control system for temperature, ventilation rate and room pressurization. | *Prudent Practices* | ☐Yes ☐No ☐NA |
| Laboratories areas are negatively pressurized relative to the adjacent spaces. | BOR | ☐Yes ☐No ☐NA |
| Fume hood exhaust duct connections meet installation criteria and are secured. | BOR | ☐Yes ☐No ☐NA |
| Exhaust ductwork are fire and corrosion-resistant and selected based on resistance to the primary corrosive present. | *ANSI Z9.5*<br>*NFPA 45,* | ☐Yes ☐No ☐NA |
| Exhaust from hoods used for teaching are routed to blowers different from those used to exhaust air from research labs. | *Prudent Practices* | ☐Yes ☐No ☐NA |
| Exhaust system ductwork **IS NOT** internally lined with fiberglass, mineral wool, foam or such material that can accumulate chemical deposits. Sound baffles or external acoustical insulation should be used for noise control. | *NFPA 45*<br>*Prudent Practices* | ☐Yes ☐No ☐NA |
| Hoods with exhaust streams that may contain flammable or explosive vapors at concentrations above the Lower Explosion Limit as well as those that might form explosive compounds (i.e., perchloric acid hood exhaust) are not connected to a centralized exhaust system. | *ANSI Z9.5* | ☐Yes ☐No ☐NA |
| Perchloric acid hoods have a connected, identified, working wash-down system. | BOR | ☐Yes ☐No ☐NA |
| Hoods are labeled to show the fan or ventilation system to which they are connected to. | NFPA 45<br>Best Practice | ☐Yes ☐No ☐NA |
| Hood duct connectors are labeled to identify the hood they serve. | BOR<br>NFPA 45 | ☐Yes ☐No ☐NA |

| | | |
|---|---|---|
| Exhaust from lab does not pass un-ducted through other areas | *NFPA* | ☐Yes ☐No ☐NA |
| Fume hood ducting is properly connected to an exhaust fan (if not manifold). | BOR | ☐Yes ☐No ☐NA |
| Fume hood fan drive and motor units are properly guarded. | BOR | ☐Yes ☐No ☐NA |
| Fume hood exhaust fans are permanently identified as to the hoods they serve. | BOR | ☐Yes ☐No ☐NA |
| Fume hood exhaust stacks are oriented vertically and terminate at least 10 feet above the adjacent roof lines and air intakes. | *BOR*<br>*ANSI Z9.5 5.3.5* | ☐Yes ☐No ☐NA |
| Each exhaust stack has a minimum discharge velocity of 3,000 fpm unless it's demonstrated that a specific design achieves the necessary dilution. | *BOR*<br>*ANSI Z9.5*<br>*ASHRAE* | ☐Yes ☐No ☐NA |
| Exhaust duct dampers and valves are accessible for adjustment or service work. Exhaust fans are located and arranged so as to allow for periodic cleaning, inspection, repairs and maintenance. | *BOR*<br>*ANSI Z9.5*<br>*NFPA 45* | ☐Yes ☐No ☐NA |
| Exhaust discharges are located away from supply air intakes and designed so as to prevent contaminated exhausts from being re-entrained into the building. | *ASHRAE*<br>*ANSI Z9.5* | ☐Yes ☐No ☐NA |
| Wind engineering evaluations have been conducted to ensure that re-entrainment of exhaust will not occur, or that potentially hazardous exhaust will not impact nearby buildings. | *Prudent Practices* | ☐Yes ☐No ☐NA |
| Test and balance work has been completed, verifying proper installation before closeout. | BOR | ☐Yes ☐No ☐NA |

## BIOLOGICAL SAFETY CABINETS

| | | |
|---|---|---|
| All biological safety cabinets (BSCs) meet the specifications of the most recent edition of the National Sanitation Standard 49 – Class II (Laminar Flow) Biohazard Cabinetry. | Best Practice | ☐Yes ☐No ☐NA |
| At a minimum, Class II A1 or Class II A2 BSCs are provided for biohazard work. | CDC-NIH | ☐Yes ☐No ☐NA |
| Type II A BSCs are not "hard-ducted" into the building exhaust system. | *CDC-NIH BMBL* | ☐Yes ☐No ☐NA |
| BSCs provided have at least 6 inches side and 18 inches top clearance. | BOR | ☐Yes ☐No ☐NA |
| The BSCs located away from doors and high-traffic areas, and such that air supply diffusers do not affect airflow at the BSC face. | *BOR*<br>*CDC-NIH BMBL* | ☐Yes ☐No ☐NA |
| BSC wrappings are essentially left in place until dusty area work is completed. | BOR | ☐Yes ☐No ☐NA |
| Required BSC service fixtures are installed and work properly. | BOR | ☐Yes ☐No ☐NA |
| BSCs are certified by an accredited certifier. | BOR | ☐Yes ☐No ☐NA |

## EMERGENCY EYEWASH & SAFETY SHOWERS

| | | |
|---|---|---|
| An emergency Eye-wash and Safety-shower is provided at all work areas where, during normal operations or emergencies situations, the body may come into contact with a hazardous substance | CFR 1910.151(c) | ☐Yes ☐No ☐NA |
| Emergency eyewash and safety shower comply with the requirements of ANSI/ISEA Z358.1-2009 "Emergency Eye Wash and Shower Equipment" | ANSI/ISEA Z358.1 | ☐Yes ☐No ☐NA |
| Emergency eyewash facilities and safety showers are in unobstructed and accessible locations that require no more than 10 seconds for the injured person to reach along an unobstructed pathway. | *BOR*<br>*ANSIZ358.1*<br>*Prudent Practices* | ☐Yes ☐No ☐NA |
| Emergency eyewash/shower install to meet ADA accommodation - disabled person can access it within 10 seconds of an ADA fume hood | BOR | ☐Yes ☐No ☐NA |
| Safety showers are located at least 4 feet from walls (preferably near a sink). | BOR | ☐Yes ☐No ☐NA |
| No electrical apparatus, telephones, thermostats, or power outlets are to be located within 18 inches of either side of the emergency shower or emergency eyewash facility. | *NFPA 70 (NEC)*<br>*Prudent Practices* | ☐Yes ☐No ☐NA |
| Safety shower heads are installed 4 inches below ceiling. | BOR | ☐Yes ☐No ☐NA |
| Safety shower valve rods or handles are within easy reach of deluge area. | BOR | ☐Yes ☐No ☐NA |
| Safety showers have an identified in-line shut-off valve | BOR | ☐Yes ☐No ☐NA |
| Screen filters in water supply line (if installed by manufacturer) are removed. | BOR | ☐Yes ☐No ☐NA |

| | | |
|---|---|---|
| Safety shower water flow is at least 20 gpm. | BOR | ☐Yes ☐No ☐NA |
| Safety shower water flow stops dripping within 1 minute of shut-off. | BOR | ☐Yes ☐No ☐NA |
| Safety shower signage is installed, visible from any direction. | BOR | ☐Yes ☐No ☐NA |
| Eyewashes are plumbed into the cold water line at or near a major sink. | BOR | ☐Yes ☐No ☐NA |
| Eyewashes have twin-stream nozzles, properly anchored to maintain position. | BOR | ☐Yes ☐No ☐NA |
| Eyewash nozzle filters are not installed until water supply lines are flushed out. | BOR | ☐Yes ☐No ☐NA |
| Eyewash water flow is at least 3 gpm. | BOR | ☐Yes ☐No ☐NA |
| Eyewash water pressure is gentle (adjusted to criteria guideline). | BOR | ☐Yes ☐No ☐NA |
| Eyewash water stream is not blocked by cabinetry or other equipment. | BOR | ☐Yes ☐No ☐NA |
| Eyewash valve handle remains on when activated. | BOR | ☐Yes ☐No ☐NA |
| Eyewash signage is installed, visible from any direction. | BOR | ☐Yes ☐No ☐NA |

## CHEMICAL STORAGE (STOCKROOMS)

| | | |
|---|---|---|
| Dedicated space(s) for storage of chemical with the appropriate ventilation and fire suppression is provided for? | BOR<br>Prudent practices | ☐Yes ☐No ☐NA |
| Chemical storage rooms have an independent air supply. | BOR | ☐Yes ☐No ☐NA |
| Storage rooms are located adjacent to the laboratories they support. with storage cabinet for flammable materials and vented cabinet for toxic and odorous materials. | Prudent practices | ☐Yes ☐No ☐NA |
| Storage cabinets of flammable, corrosive, and toxic materials are provided and labeled | Prudent practices | ☐Yes ☐No ☐NA |
| Flammables cabinets provided are UL or FM certified. | BOR | ☐Yes ☐No ☐NA |
| Flammables cabinets provided have positive latching, self-closing doors. | BOR | ☐Yes ☐No ☐NA |
| Flammables cabinets provided are not vented. Vent caps are in place. | BOR | ☐Yes ☐No ☐NA |
| Flammables cabinets provided have a retention basin for leak containment. | BOR | ☐Yes ☐No ☐NA |
| Corrosives cabinets provided are non-corroding and have spill containment. | BOR | ☐Yes ☐No ☐NA |

## HAZARDOUS WASTE AND POLLUTION PREVENTION

| | | |
|---|---|---|
| A dedicated central space for storage of hazardous waste (180/90 days accumulation) with the appropriate ventilation and fire protection is provided for? | KSU | ☐Yes ☐No ☐NA |

| | | |
|---|---|---|
| Liquid effluent from labs is discharged through a central acid neutralization tank with monitoring system | Best practice | ☐Yes ☐No ☐NA |
| Lab sinks, drains and equivalent discharge points are connected to wastewater system and not storm water system | CC-ordinance | ☐Yes ☐No ☐NA |
| Lab countertops or lab sinks are separated with a ridge or lip to prevent hazardous or other regulated materials spilled on the countertops from draining into the sink. | Best practice | ☐Yes ☐No ☐NA |
| No unpolluted cooling water discharge, groundwater, roof or basement drainage is connected to the wastewater system. | CC-Ordinance | ☐Yes ☐No ☐NA |
| Appropriate spill containment is ensured for outdoor oil-filled electrical equipment (transformers). Transformer pad should be surrounded by gravel or other containment measures to prevent the lateral migration of oil from reaching a drainage inlet. | CC-Ordinance | ☐Yes ☐No ☐NA |

## FIRE AND LIFE SAFETY

| | | |
|---|---|---|
| Standpipes are provided for laboratory buildings with two or more stories above or below the grade level. | NFPA 45 | ☐Yes ☐No ☐NA |
| Automatic sprinkler system is provides per NFPA 13 | NFPA 45 | ☐Yes ☐No ☐NA |
| Portable fire extinguishers are provided for and appropriately distributed in accordance with NFPA 10. | NFPA 10;<br>NFPA 45 | ☐Yes ☐No ☐NA |
| Cabinets and shelving are not located to impede sprinkler head water flow | BOR | ☐Yes ☐No ☐NA |
| Emergency power back-up provided to fume hood for sensitive chemical and biological experiments. | Prudent practices | ☐Yes ☐No ☐NA |
| Back-up exhaust fan power kicks in within 3 seconds of a manifold fan failure. | BOR | ☐Yes ☐No ☐NA |
| All fire detection, alarm and communication systems are designed in accordance with appropriate NFPA and NEC requirements? | NFPA 45 | ☐Yes ☐No ☐NA |
| Panic hardware are installed on exit doors | NFPA 45;<br>NFPA 101 | ☐Yes ☐No ☐NA |
| Adequate illumination of “means of egress” and emergency lighting is provided. Use of tritium (or other radioactive material) emergency lighting is not allowed. | NFPA 45<br>NFPA 101 | ☐Yes ☐No ☐NA |
| Laboratory aisles are at least 4 feet in width. | BOR | |
| Corridors/halls are wide enough to accommodate occupant traffic and potential art displays/exhibits, where necessary. | NFPA 101<br>Prudent practices | |
| A dedicated space (at least 5ft x 5ft) for storage of emergency equipment is located on each lab floor (lab zone) | KSU<br>Prudent practices | ☐Yes ☐No ☐NA |

## ELECTRICAL SAFETY

| | | |
|---|---|---|
| Adequate electrical receptors provided at an appropriate distribution in order to preclude future need for use of extension cords | Prudent Practices | ☐Yes ☐No ☐NA |
| Receptacles of appropriate voltage and current ratings are provided for known equipment in order to avoid overloading. | *NFPA 70*<br>*Prudent Practices* | ☐Yes ☐No ☐NA |
| Electrical receptacles, switches, and controls are located so as not to be subject to liquid spills. | *NFPA 45* | ☐Yes ☐No ☐NA |
| Ground Fault Circuit Interrupter (GFCI) protection provided for convenience receptacles located within 6 feet of a sink or other wet location. | *NFPA 70*<br>*BOR* | ☐Yes ☐No ☐NA |
| Panel circuits, including GFCI, are properly identified. | BOR | ☐Yes ☐No ☐NA |
| Adequate clear space provided in front and to the sides of each electrical circuit breaker panel and equipment disconnect. | *NFPA 70*<br>*Prudent Practices* | ☐Yes ☐No ☐NA |
| Circuit-breaker panels located outside the laboratory whenever possible. | *Prudent Practices* | ☐Yes ☐No ☐NA |
| Each circuit-breaker panels has built-in lockout devices. | NFPA 70<br>Prudent practices | ☐Yes ☐No ☐NA |
| Electrical power lines are not commingled in a cable tray with other utilities (e.g., electrical, gas, water, etc.). | *NFPA 70* | ☐Yes ☐No ☐NA |
| Electrical service fixtures of required types have proper covers. | BOR | ☐Yes ☐No ☐NA |

## COMPRESSED GAS CYLINDERS & PRESSURE VESSEL

| | | |
|---|---|---|
| Compressed gas cylinder storage area is provided. | BOR | ☐Yes ☐No ☐NA |
| Compressed gas storage area is provided with racks to adequately secure gas cylinders by chains, metal straps, or other approved materials, to prevent cylinders from falling or being knocked over. | *BOR*<br>*NFPA 45* | ☐Yes ☐No ☐NA |
| Cylinder restraints sufficient to prevent the cylinder from tipping over. | *Prudent Practices*<br>*NFPA 45* | ☐Yes ☐No ☐NA |
| Compressed gas cylinder closets have required venting. | BOR | ☐Yes ☐No ☐NA |
| Vented gas cylinder closets have gas sensing devices and an alarm. | BOR | ☐Yes ☐No ☐NA |
| Compressed gas supply lines are properly identified. | BOR | ☐Yes ☐No ☐NA |

## SHIPPING RECEIVING AREAS (LOADING DOCKS)

| | | |
|---|---|---|
| The shipping/receiving area has proper vehicle clearance and access. | KSU | ☐Yes ☐No ☐NA |
| Utility lines and pipes are appropriately protected from vehicular impact | KSU | ☐Yes ☐No ☐NA |
| A telephone is installed in the receiving area | KSU | ☐Yes ☐No ☐NA |
| The receiving area has adequate lighting? | KSU<br>NFPA 101 | ☐Yes ☐No ☐NA |
| Guard rails have been provided where necessary | KSU | ☐Yes ☐No ☐NA |

| | | |
|---|---|---|
| Shipping/receiving areas handling hazardous materials is equipped with fire extinguishers and an emergency eyewash and shower. | Prudent Practices | ☐Yes ☐No ☐NA |
| Loading docks is designed to prevent the run-on of storm water and runoff of spills. – inward sloping, covered or use of berms/dikes | KSU<br>Prudent Practices | ☐Yes ☐No ☐NA |
| **PLUMBING** | | |
| Water supply and drain connections are tested as correctly installed and working. | BOR | ☐Yes ☐No ☐NA |
| Any plumbing leaks (water, drains, and gases) are repaired (all fixtures). | BOR | ☐Yes ☐No ☐NA |
| Water service fixtures have vacuum breakers and cut-off valves. | BOR | ☐Yes ☐No ☐NA |
| Water service fixture valves turn on/off in required direction. | BOR | ☐Yes ☐No ☐NA |
| Special water service installations have self-closing valves. | BOR | ☐Yes ☐No ☐NA |
| Cup sinks have strainers secured in place. | BOR | ☐Yes ☐No ☐NA |
| **GENERAL** | | |
| Laboratory wall, corner, and surface moldings are in place and secured. | BOR | ☐Yes ☐No ☐NA |
| Laboratory aisles are at least 4 feet in width. | BOR | ☐Yes ☐No ☐NA |
| Clear wall space at doors is at least 2 feet. | BOR | ☐Yes ☐No ☐NA |
| Cabinets and shelving are not located to impede sprinkler head water flow. | BOR | ☐Yes ☐No ☐NA |
| Air supply vents are not close to chemical fume hoods and biosafety cabinets. | BOR | ☐Yes ☐No ☐NA |
| Disability (ADA) design considerations are taken into account. | BOR | ☐Yes ☐No ☐NA |
| Cabinet, countertop, and fume hood materials are appropriate for uses. | BOR | ☐Yes ☐No ☐NA |
| Cabinetry meets the size criteria. | BOR | ☐Yes ☐No ☐NA |
| Sliding doors have required stops. | BOR | ☐Yes ☐No ☐NA |
| Reagent shelving is 5 feet from the floor. | BOR | ☐Yes ☐No ☐NA |
| Reagent shelving has ½ -inch retaining lips. | BOR | ☐Yes ☐No ☐NA |
| Doors and drawers do not stick when opened and closed. | BOR | ☐Yes ☐No ☐NA |
| Panels are all in place and properly secured. | BOR | ☐Yes ☐No ☐NA |
| Service fixtures are properly positioned and secured in place. | BOR | ☐Yes ☐No ☐NA |
| Service fixtures, lab and chemical fume hoods, are properly identified and color-coded. | BOR | ☐Yes ☐No ☐NA |

APPENDIX B: Glossary of Terms

## Definitions

| | |
|---|---|
| Auxiliary air | A fume hood system that provides direct outside air to the front of a fume hood to save energy by exhausting up to 70% of it directly to the outside through the hood instead of exhausting 100% of laboratory air directly out. |
| Backsplash | The raised portion of a laboratory counter that abuts to the wall at the back of the counter. |
| Bypass | The fume hood feature that provides an alternative route for air to pass through the top opening of a fume hood when the sash is closed, maintaining the prescribed (exhaust) airflow rate. |
| Dead air pocket | A space within a fume hood superstructure where air is moving either poorly or not at all. |
| General-purpose | A fume hood used to exhaust contaminants created from normal laboratory interactions between chemicals or toxic materials. The hood system is capable of adjustment to vary exhaust air in proportion to the hood face opening by either changing the speed of the exhaust fan (motor speed controller or belt drive pulley) or by adjusting a duct damper setting. |
| Drain trough | A special configured laboratory counter having a drain basin, typically along the back, for discharging non-hazardous liquids involved in laboratory experiments. |
| Fume hood | A box-like structure enclosing a source of potential air contamination with an opening in the front into which air enters to exhaust air contaminants at the rear. |
| High Performance Chemical Fume Hood | A fume hood with containment-enhancing features to operation at lower face velocities (e.g. 60 - <100 FPM) while protecting the operator. These types of hoods are based on the Berkeley 2 design and also are called low velocity chemical fume hoods. |
| Life cycle costs | Net present value and internal rate of return. |
| Maintenance points | Any reasonable access that may be required to service equipment as part of a preventive maintenance program. |
| Manifolded Exhaust Systems | Units of duct work designed to increase fume dilution, augment redundancy and provide design flexibility. |
| Microscale | A usable amount of something reduced in size, item by item. |
| Pyrophoric | Capable of spontaneously igniting in air. |
| Reagent shelving | Shelving used to store chemicals having hazard classification of 2-3-4 under NFPA or 1-2-3 under the Global Harmonized System labeling requirements. |

| | |
|---|---|
| Set-back | A reduced energy setting typically used when areas are unoccupied. |
| Significant renovation | Any building containing laboratories in which the ventilation system is significantly changed (e.g. rebalancing of HVAC) or the facility is repurposed. |
| Special purpose | A hood system of atypical design for special operations and/or apparatus. |
| Test and Balance | Adjustment procedure to HVAC systems and chemical fume hoods that sets parameters to design specifications for building or area air supply and exhaust. |
| Variable air volume (VAV) system | A laboratory fume hood air control system that varies the exhaust air volume in proportion to the hood face opening by either changing the speed of the exhaust fan or adjusting an exhaust duct damper. |

## APPENDIX C: Acronyms

| | | |
|---|---|---|
| ADA | Americans with Disabilities Act | www.usdoj.gov/crt/ada |
| AIHA | American Industrial Hygiene Association | www.aiha.org/Content |
| ANSI | American National Standards Institute | www.ansi.org |
| ASHRAE | American Society of Heating, Refrigeration, and Air Conditioning Engineers | www.ashrae.org |
| BoR – USG | Board of Regents – University System of Georgia | www.usg.edu/ehs |
| BSC | Biological safety cabinet | |
| CAV | Constant air volume | |
| CDC | Centers for Disease Control and Prevention | www.cdc.gov |
| DC | Design criteria (this document) | |
| EMS | Energy management system | |
| FPM | Feet per minute (linear airflow rate) | |
| HEPA | High efficiency particulate air (filter) | |
| HVAC | Heating, ventilation, and air-conditioning | |
| LFB | Laminar flow bench | |
| NESHAP | National Emission Standards for Hazardous Air Pollutants | |
| NFPA | National Fire Prevention Association | www.nfpa.org |
| NSF | National Sanitation Foundation (International) | www.nsf.org |
| SEFA | Scientific Equipment and Furniture Association | www.sefalabs.com |
| T&B | Test and balance (building air systems) | |
| UL | Underwriters Laboratories | www.ul.com |
| USDHHS | U.S. Department of Health & Human Services | www.hhs.gov/ |

APPENDIX D: Institution Guidelines For Laboratory Safety Equipment

A. CHEMICAL FUME HOODS

A. Annual Verification (NEW GUIDANCE FOR INSTITUTIONS)

1. Each USG Institution shall provide annual verification of all chemical fume hoods in use by suitable quantitative (e.g. airflow) and qualitative (e.g. visual challenge) testing in the as used (AU) condition, consistent with the latest ASHRAE 110 method. Some adaptation may be required depending on set-backs, sensing methods, etc. Institutions are encouraged to use third party testing firms that specialize in this type of commissioning/testing. Testing firms should be qualified and provide proof of competency, to be determined by the institution. As a general rule, these specialized testing firms should have at least 50% gross revenue associated with testing chemical fume and/or biological safety cabinets.
2. Institutions should consider testing all high performance hood systems to the full ASHRAE 110 testing requirements every 5 years.

B. Hood identification

1. It is recommended that all chemical fume hoods be numbered for ease of tracking, for certifications and repair work. Penthouse or mechanical chase ducts and roof exhaust fans should also be labeled. This is especially helpful in finding the right roof fan unit and/or duct when attempting to make an adjustment or repair. Weather-resistant labeling for roof fans is best.

C. Hood use

Work surfaces should be kept clean and clear when hood is not in use. All objects should be kept inset at least 6 inches behind the sash.

1. Large equipment used in a hood should be raised an inch or more off the hood base to allow airflow under it.
2. When using a perchloric acid hood, the wash-down system should be used prior to using perchloric acid within the hood.
3. Spills and residues within a hood should be cleaned up promptly.

D. Hood storage

1. Chemical fume hoods shall not be used primarily for the storage of chemicals or for evaporating chemicals from containers.
2. The use of shelving within a hood is recommended to enhance design airflow within the hood by letting air exhaust more readily from the rear interior openings to the duct.
3. Contents within a hood should not block rear openings at any level. Baffles should not be completely closed off.

II. BIOLOGICAL SAFETY CABINETS

A. Cabinet Numbering and Tracking

It is recommended that all biological safety cabinets (BSC) and laminar flow benches (LFB) be numbered, listed, and tracked continuously during their use life by the owning institution.

B. Cabinet Certification

Annual recertification is required NSF49, or whenever a BSC or LFB is moved to another location (within or out of the same room), or after a repair. Only accredited certifiers should perform this work. It is recommended that certifier credentials be obtained and filed for reference.

C. Open flames

Open flame devices within a BSC create a potential for fire and should not be used in a BSC.

D. Maintenance work

All repairs made on BSCs should be made by a qualified technician. Any malfunction in the operation of the BSC should be reported and repaired before the BSC is used again.

III. EMERGENCY SAFETY SHOWERS

A. Annual Flushing

Refer to VI-D.

B. Tagging

C. Safety showers should be tagged for continuous proof of servicing.

IV. EYEWASH UNITS

A. Annual Check

Refer to VI-D

B. Weekly Flushing

C. Departments should flush eyewash units weekly to maintain a clean line.

D. Tagging

Eyewash units should be tagged for continuous proof of service.

E. Filters Replacement

Filter replacement is optional. Rusty, moldy, or disintegrating filters should be removed and discarded.

V. COMPRESSED GAS CYLINDERS

A. Cylinder Storage

Except for one spare (for each gas), extra cylinders shall not be staged or left in laboratory units, as defined in NFPA Code 45.8.1.6.3, but must be kept out of the laboratory unit until ready for hook-up.

B. Cylinder Compatibility

Cylinders must be compatibly stored or separated within appropriate fire barriers.

# 8. APPENDIX E: **Document History**

**5th Revision November 2019**

*Major Changes*

- Scope
- Hazard Assessments
- Local Exhaust Ventilation (other than chemical fume hoods)
- Relocation and Repair of BSCs
- Lower Air Exchange Rates
- Laminar Flow Hood
- Variance requirement from Fire Marshal's office if deviation from present fire code
- Modesty Screens
- Water Tampering
- Cabinet Venting

**4th Revision November 2013**

*Major Changes*

- Addition of high performance chemical fume hoods
- Chemical fume hood testing requirements for newly/moved units
- Emergency power backup added
- Modification to requirements for emergency safety showers & eyewash stations
- Laminates prohibited for work surfaces where chemicals, biological agents, etc are used
- Appendix A checklist replaced
- Definitions added to Appendix B
- Appendix D aligned with chemical fume hood testing in V-K3
- Former Appendix E (fume hood example) deleted
- Appendix E created for document history

**3rd Revision: October 2007**

**2nd Revision: November 2000**

**Initial Document December 1998**