Board of Regents of the University System of Georgia

Design Criteria for Laboratories

Effective: October 2007

Supercedes: November 2000

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APPENDIX

The following recommended practices are provided for University System of Georgia institutions to follow as management guidelines for laboratory safety equipment.

INSTITUTION GUIDELINES FOR LABORATORY SAFETY EQUIPMENT (Recommended Practices)

I. SCOPE, PURPOSE AND GENERAL REQUIREMENTS

A. Primary Purpose

The primary purpose of these design criteria (DC) is to establish minimum design requirements for laboratory furniture, fume hoods, and safety devices to provide a safe work environment and prevent undesirable exposures to chemical contaminants among students, faculty, and staff in University System of Georgia (USG) laboratories.

B. Minimum Standards

These design criteria are minimum design standards required for all new construction and renovation projects involving laboratory furniture and fume hoods in USG facilities. Individual institutions may have more stringent requirements.

C. Standard References

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

- *National Fire Protection Association (NFPA) 45 - Standard on Fire Protection for Laboratories Using Chemicals*
- *NFPA 30 – Flammable and Combustible Liquids Code*
- *NFPA 70 – National Electric Code*
- *American National Standards Institute (ANSI) / American Industrial Hygiene Association (AIHA) Z9.5 - Standard for Laboratory Ventilation*
- *ANSI/AIHA Z358.1 – Standard for Emergency Eyewash & Shower Equipment*
- *American Society for Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 55 – Thermal Environment Conditions for Human Occupancy*
- *ASHRAE 110-R*
- *Americans With Disabilities Act Accessibility Guidelines (ADAAG) – Official Code of Georgia Annotated (O.C.G.A.) 30-3-2.*
- *US Department of Labor, Occupational Safety and Health Administration (OSHA), Occupational Exposure to Hazardous Chemicals in Laboratories, 29 CFR 1910.1450*

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" (BPP). The BPP is available online at http://www.usg.edu/ref.

D. Drawings

1. Working drawings.

During the preliminary design phase of the project, designers shall develop and submit a draft set of working drawings to the appropriate representatives at the institution (Facilities Construction/Engineering, Physical Plant, Environmental Safety, and involved academic unit) for review and comment.

Upon institution 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 Office of Facilities, 270 Washington St., S.W., Atlanta, GA 30334, for review and comment by 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 facilities shall be the approving authority for preliminary design documents.

2. Shop drawings.

The designer shall submit shop drawings to the architect showing rough-in and installation drawings. Designers 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. Designers shall provide drawings in an approved electronic format if requested by the institution.

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

3. Manufacturer's information.

Manufacturer's data and installation instructions shall be procured and submitted with purchased fume hood, along with recommended ductwork seam connection methods and materials (if not welded).

4. Samples.

All prospective bidders shall, upon request, submit samples.

5. Final drawings.

After changes are made, designers shall develop a final set of working drawings, to be submitted in accordance with the most current version of the Board of Regents BPP.

E. Institution Review and Acceptance

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 Engineering, Environmental Safety, and involved academic units.

2. Test and balance reports.

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

F. Variance Requests

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

G. Fume Hoods Minimization

To minimize the overall number of 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.

Fume hoods shall not be installed or used primarily for the chemical storage.

H. Laboratory Air Pressurization and Exchange Rate

Laboratories where potentially hazardous chemicals or agents are used 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.

II. LABORATORY LAYOUT

A. Floor Area

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 over open aisles to provide maximum air distribution and circulation and needed accessibility for airflow rate/volume testing.

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.

3. Cabinet and shelf locations.

Cabinets and shelving shall not be located directly under sprinkler heads to prevent stacked materials from impeding water flow.

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.

5. Doorway width.

Doorways into laboratories having fume hoods and/or other 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.

6. Flooring.

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

B. Airflow Patterns

1. Air turbulence.

Laboratory size and layout clearances shall be coordinated with HVAC design and fume hood placement to avoid creating turbulent air near fume hoods or biological safety cabinets, and dead air pockets or reverse air currents along the hood opening. Hoods should be located away from aisles, doors, and air supply vents.

2. Chemical storage room HVAC.

Rooms intended for the storage of hazard chemicals shall be a minimum of 1-hour fire-rated construction and shall have a non-recirculating exhaust air system.

III. GENERAL INFORMATION AND SPECIFICATIONS

A. Specification Criteria

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

B. Accessible Design

Laboratory furniture and fume hoods meeting the requirements of the Americans with Disabilities Act (ADA) shall be provided where necessary to comply with Georgia Code.

C. Quality Assurance

1. Equipment compatibility.

   Laboratory furniture, counter tops, sinks, service fixtures, and fume hoods shall be compatible and provide built-in safety design features.

2. Catalog numbers.

   Manufacturer's catalog numbers shall be indicated on drawings to identify 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.

3. 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.

IV. LABORATORY FURNITURE & FIXTURE SPECIFICATIONS

All casework, counter tops, utility service fixtures, fume hoods 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.

A. 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.

1. Cabinetry materials.

Standard, floor-mounted, closed-base cabinetry with or without access doors, shall be used in all laboratories.

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 in storage and workrooms requiring base or wall storage of equipment and where appropriate color matches are desired. Only non-combustible and non-reactive laminates may be used where flammable, corrosive, or reactive materials are stored or used.

2. Base cabinets.

Base cabinets shall be in accordance with the plans and elevation drawings as to size, location, door and drawer configuration.

a. 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.

b. Scribes shall be used where casework or filler panels abut walls, columns, pilasters or other casework.

c. Filler panels shall be provided to enclose spaces between casework and abutting surfaces.

d. Casework shall be constructed with a flush-lipped overlap on all four sides of doors and drawers.

3. Wall cases.

a. Wall cases shall have wood-framed glass sliding doors and be in accordance with the plans and elevation drawings as to size and location.

b. Bypass stops shall be included on all sliding doors.

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. Reagent racks.

Reagent racks shall be constructed of the manufacturer's standard materials for reagent racks, coated with a chemical-resistant finish, and of the size, configuration and location per contract documents.

6. Reagent shelving.

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

a. Shelving shall have a ½-inch retaining lip.

b. Shelving height shall not exceed 5 feet from floor.

c. Shelving shall be coated with a chemical-resistant finish.

7. Pegboards.

a. Pegboards shall be constructed of manufacturers' standard materials for pegboards.

b. Pegboards shall be made of chemical resistant material or coated with a chemical-resistant finish.

c. Pegboards shall be of the size and location as shown on the plans or elevation drawings.

d. Pegs shall be polypropylene or equivalent chemical resistant material.

8. Tables.

a. Tables shall be constructed of solid hardwood or metal with tops as specified under "surfaces" in this document.

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

9. 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.

B. Casework Installation and Performance

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.

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. Scribes 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 and filler panels and scribes shall be structurally integrated and of neat appearance.

e. Rigid molding (such as 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 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.

Cabinet doors and drawers shall open and close without sticking. Wall case and storage case doors shall operate without sticking.

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. 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.

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 1-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 abut 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. Countertop installation

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

C. 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.

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.

2. Cold water service fixtures.

Cold water service fixtures shall be provided with an integral vacuum breaker and a 10-serrated hose connection end. 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:

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

3. Gas, air, vacuum service fixtures.

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

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. 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.

6. Cupsinks.

   a. Cupsinks shall be 6 inch inside diameter, hemispherical at double-faced island and peninsular assemblies, *and/or*

   b. 3 inch by 6-inch oval configuration along wall assemblies, with secured strainer.

7. Neutralization tanks.

   Neutralization tanks shall be designed and installed in accordance with the most recent version of the International Plumbing Code. Such units, whether located outside the building, underground, or under sinks in labs, shall be designed and located to provide for safe access and regular maintenance.

8. Bench-top drain troughs.

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

9. Floor drains.

   Floor drains may be 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. The drains shall be equipped with flush-mounted caps so that inadvertently spilled chemicals or other undesirable materials will not enter the sanitary sewer system. In addition, the neutralization tanks referenced in section IV-C.7 above shall provide a redundant means of containment for inadvertently spilled materials which may enter the drain system. 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 shall be installed, as necessary, to prevent drying out of seldom-used floor drains.

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.

b. 208-volts, single or 3-phase, 3 or 4-wire polarized receptacle. 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 excepted from this requirement.

11. Electric circuits.

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

D. Service Fixture Installation and Performance

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

V. FUME HOODS

A. Fume Hood Selection

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.
   b. Designers 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 loops; use of horizontal sliding sashes, etc.
   c. Recirculation of any laboratory fume hood exhaust air is prohibited.
   d. Consideration shall be given to installing combination high efficiency particulate air (HEPA) and/or organic vapor (OV) filters for laboratory fume hoods or individual exhaust duct systems where compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) may be an issue.

e. Designers shall specify fume hood exhaust ductwork based on good safety and engineering principles.

f. During schematic design, the institution user group(s) shall provide the designer with a complete list of chemicals anticipated for use to assist in the selection of appropriate exhaust duct materials.

g. The exhaust ductwork materials shall be selected based on code compliance and compatibility with the chemicals and agents planned for use.

h. **Ductless** fume hoods are **prohibited**.

i. 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 and+/- 20% of design flow rates.

j. Locations of plumbing and electrical service connections shall be determined from the supplier's rough-in drawings.

2. 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. Hoods greater than five-foot width shall not be used for any radiation or perchloric acid activities.

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. 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.

B. Fume Hood Airflow Requirements

1. Airflow rate.

Standard bypass, constant volume fume hoods and variable air volume (VAV) hoods shall be designed to maintain a face velocity of **100 feet per minute** (fpm), **+/- 20%,** with the sash open 18 inches. This requirement applies to general purpose, special purpose, radiation, and perchloric acid hoods. In addition, alternative fume hood design strategies which may be capable of maintaining the required level of safety and capture efficiency at lower face

velocities may be considered on a project-by-project basis. Documentation verifying safety and capture efficiency performance of the proposed alternative fume hood design strategy shall be provided by the project designer in advance to the engineering and environmental health and safety departments at the institution for use in their decision-making process. If the institution decides to employ such an alternative fume hood design strategy, written justification – including a summary statement of the institutions preference and capability to maintain the system – must be provided as part of the preliminary design documents and must be specifically presented at the preliminary design meeting at the Board of Regents Office of Facilities.

2. Air passage.

a. Non-bypass constant volume fume hoods are prohibited.

b. Variable air volume (VAV) fume hoods may be considered for general or special purpose hood applications only. They must be capable of maintaining the required hood face velocity (100 fpm =/-20%) and have a low airflow alarm installed as noted under parts V-B-1 / V-G-5.

c. 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.

C. Fume Hood Types

Laboratory fume hoods shall be either standard bypass constant volume, variable air volume (VAV), or auxiliary air.

1. Standard bypass hoods.

Standard by-pass 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 fume hoods are prohibited.

2. Variable air volume (VAV) hoods.

VAV fume hoods have an air control 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.

3. High performance / low-flow hoods.

High performance / low-flow hoods are specially designed hoods which are premised on an internal articulating baffle to create greater hood containment

efficiency at lower flow rates such as 50-70 lfpm. These hoods may be considered for USG projects on a case-by-case basis as determined via thorough analysis by the project designer, the institution and the Board of Regents Office of Facilities.

D. Fume Hood Applications

1. General-purpose use.

A bypass type hood with an airfoil and sash is often the hood of choice used 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 may 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. **Note**: General-purpose auxiliary-air hoods, designed to furnish up to 70% outside air to be drawn into the hood from a point outside the sash, may be considered on a case-by-case basis for installation on renovation projects only (no new construction).

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.

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.

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. 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.

E. Fume Hood Location

Fume hoods shall be located per the requirements of ANSI/AIHA Z9.5 (most recent version) to minimize excessive airflow cross-drafts in the laboratory, in accordance with sound engineering principals.

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 hood capacity load.

F. Submittals

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

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

2. 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).

G. Fume Hood Components

1. Approvals.

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) that their fume hoods are capable of maintaining a sustained safe working environment for laboratory personnel.

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.

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 1/4th to ½-inch raised edge around the interior periphery of the fume hood for spill containment.

4. Service fixtures

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

a. All plumbing service fixtures shall 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 shall 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 shall be provided mounted in the countertop:
   - Unless otherwise specified, 1 cupsink for each water fixture on one interior side of 3-foot and 4-foot width hoods.
   - 5-foot and 6-foot width hoods shall 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:
   - 2 120-volt A.C., GFCI-protected outlets.
   - 1 or more 240-volt A.C., GFCI-protected outlets.

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 fluorescent 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).

5. Low airflow alarm console.

New fume hoods shall be provided with a low airflow alarm console to warn of

hood exhaust average airflow velocity falling below 80 fpm or, in the case of approved alternative fume hood designs, more than 20% below the lowest full-open sash face velocity at which the fume hood is approved.

a. A factory-mounted safety alarm console shall be recess mounted into the hood facing according to alarm console manufacturer's instructions.

b. Air velocity sensors, if external, shall be installed and identified per the manufacturer's instructions, and be easily accessible.

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.

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.

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.

7. Hood sash.

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 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 shall consist of at least two panels, movable throughout their travel by applying no more than 5 lbs. of force. They must remain stationary when force is removed.

e. Combination sashes (vertical and horizontal) 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.

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.

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.

10. Hood identification nameplates.

a. Nameplates are required for perchoric 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, reading: Use no 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.

11. Operating instructions.

Manufacturer's hood operating instructions shall be provided.

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.

H. Fume Hood Work Surface Materials

Recommended fume hood interior and work surfaces shall be either:

General or special-purpose and radiation hoods:
- Solid-resin (chemical resistant).

Perchloric acid hoods (and optional for Radiation hoods):
- Stainless steel.

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

I. Fume Hood Installation

1. Hood superstructure.

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

2. Equipment.

a. Factory-installed permanent sash stops shall be incorporated into all new laboratory 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 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 incandescent 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.

3. Fume hood exhaust ducts.

a. Exhaust duct materials shall be selected 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.

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.

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 fume hoods shall be installed vertically up.

i. One permitted exception to vertical-up ducting is for duct turns not to exceed 45º from vertical in renovation project installations (not new construction) to avoid building structural members.

ii. Another permitted exception is for horizontal ducting if connected to a manifolded exhaust system.

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 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, measured at the top of the exhaust stack.

p. Exhaust stacks shall be designed and located in accordance with ANSI / AIHA Z9.5-5.3.5 to prevent re-entrainment of contaminants back into the building.

q. Exhaust stack height shall be higher than the top of the nearest intake and at least 10 feet above the roof 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.

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.

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, desirably at roof

level, to maintain face velocity and to prevent backflow or air volume fluctuations.

b. A closed-loop feedback control shall be provided to directly measure exhaust air volume.

J. Fume Hood Performance

1. Design performance.

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).*

2. Hood performance documentation.

Documentation of hood performance, capture efficiency, and containment effectiveness shall be provided to the institution prior to acceptance of the propsed 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.

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). Fan speed shall not exceed 900 rpm, and 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.

4. Low airflow alarm activation.

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

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. Hood exhaust discharge velocity.

Hood exhaust for both constant volume and VAV hoods shall meet the discharge velocity requirements of ANSI/AIHA Z9.5 (most current version).

K. Laboratory HVAC and Fume Hood System Test & Balance

1. Installation coordination.

Designers are responsible to coordinate required installation and testing of air handling equipment and fume hood systems.

2. Test and balance requirements.

a. Each hood system shall be carefully checked 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% 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). NOTE: Alternative 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 below 80 fpm or (for alternative fume hood designs) more than 20% below the lowest full-open sash face velocity at which the fume hood is approved.

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.

3. Hood certification.

Upon installation, and before building acceptance, a fume hood certification test, such as the Scientific Equipment & Furniture Association (SEFA) protocol, or equivalent, including face velocity and smoke performance tests, shall verify acceptable hood performance.

a. Hood exhaust airflow shall be continuous at a rate of 100 fpm when vertical sash is positioned 18 inches open (constant volume and VAV hoods). Single airflow measurements, taken at the plane of the sash, should be within 20% of the average. NOTE: Alternative fume hood

designs that maintain safety and appropriate capture efficiency at lower face velocities may also be considered on a project-by-project basis, but in any case shall be within 20% of the established flow rate.

b. Hoods with horizontal sliding sash shall be tested with sash wide open. Single airflow measurements should be within 20% of the average reading.

c. Smoke should not escape the hood during the smoke capture test. There should be no dead air pockets or reverse air currents noted within the hood.

d. Low airflow alarm shall activate when sash stops are over-ridden (sash opened more than 18 inches).

L. Exhaust Manifold Systems

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.

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 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.

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 fume hoods and ducts, as well as provide sufficient exhaust velocity from exhaust ducts. This will include, as a minimum:

i. A reliable back-up emergency power source linked directly to the manifold exhaust fans.

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.

VI. OTHER LABORATORY EQUIPMENT

A. 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), laminar flow bench hoods (LFB), and glove boxes 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), Class II (Laminar Flow) Biohazard Cabinetry and "Biosafety in Microbiological and Biomedical Laboratories", U.S. Dept. of Health & Human Services (most current version).

B. BSC Descriptions

1. Design protection.

Biological safety cabinets (BSCs) are designed to protect the operator, the laboratory environment and work materials from exposure to infectious aerosols and splashes that may be generated when manipulating materials containing infectious agents such as primary cultures, stocks and diagnostic specimens. 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".

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 1 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 and can be used with volatile toxic chemicals and volatile radionuclides.

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 ducts may be under positive or negative pressure without negative pressure plenums. 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 30% of the air recirculates through the supply HEPA filter back into the cabinet's work zone with the remaining 70% 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.

C. BSC Considerations

1. Selection.

A BSC should be selected 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.

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, open windows, air supply vents, and opening and shutting 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.

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 18 inches from the ceiling.

4. Unwrapping of cabinets.

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

5. Initial certification of BSC.

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

6. Certification parameters.

a. The functional operation and integrity of each BSC should be

certified to NSF 49 specifications at the time of installation and annually thereafter by qualified technicians.

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. 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.

D. Emergency Safety Showers

1. Plumbing requirements.

Plumbed safety showers shall be properly installed, within a 10-second walking time from the location of any hazard within the laboratory area.

2. Activation valve.

Each shower shall have a manual activation and shut-off valve within easy reach of the shower head. Overhead valves shall have a rigid pull rod with handle. Wall-mounted activation valves shall be located directly adjacent to the shower pattern. It is recommended they have easily removable covers for access to the valve.

3. Showerhead location.

Showerheads shall be installed at least 30 inches from walls, preferably near a sink or inside a lab entry door clear of door swing, and 4 inches below ceiling (for ease of routine flushing). Laboratory walls located directly adjacent to safety showers shall be of water/mold-resistant construction (e.g. paperless gypsum board, mold-resistant gypsum board, water-proof coating).

4. Showerhead placement.

Showerheads shall be located at least 6 feet away from electrical service (switches, outlets, panels, etc.).

5. In-line shut-off valve.

An accessible, identified line shut-off valve shall be provided at or above ceiling within a room or shower location area.

6. In-line filter screens.

No screen filters may be installed in the water supply line. Any system-provided screens shall be removed (if installed) upon system installation.

7. Signage.

Safety shower signage shall be provided and prominently mounted near showerhead, visible from any direction of approach.

8. Water temperature.

Shower water supplied shall be tepid.

9. Water flow rate.

Water flow shall be at least 20 gallons per minute (gpm).

10. Showerhead dripping.

By design, showerhead dripping shall stop within 1 minute of valve shut-off.

11. Floor drains prohibition.

Floor drains are not permitted in laboratories.

E. Emergency Eyewash Units

1. Plumbing requirements.

Units shall be either directly plumbed or hose type units tied into the cold water

plumbing line, installed according to manufacturer's directions and meeting the requirements of ANSIZ358.1 (most current version).

All pipe-plumbed eyewashes shall connect to a sanitary sewer drain. Basin type eyewash units shall have drains sized to continuously drain away supplied water.

2. In-line shut-off valve.

Units shall have a standard line shut-off valve (with handle removed) unless line is tapped into a sink cold water line downstream of the shut-off valve.

3. Eyewash design.

Unit design shall provide twin stream nozzles to flush both eyes at once, and in a hands-free mode.

4. Nozzle filters.

Nozzle heads shall provide easy access to filters, requiring no tools for cleaning or changing when filters are dirty, disintegrated or corroded. Note: Nozzle filters should be installed after initial line flushing to remove contaminants.

5. Location and positioning.

Unit shall be securely positioned in place, universally reachable, preferably installed at a sink, at least 6 inches from other equipment, and sufficiently clear of overhead cabinetry or shelving.

6. Valve activation.

Unit shall have a non-spring-loaded, easily operated manual activation and shut-off valve.

7. Water flow rate.

Water flow shall be not less than 0.4 gallons per minute for at least 15 minutes.

8. Water pressure.

Each eyewash service line shall be provided with an adjustable supply line valve, as noted above, to regulate and control water pressure. The water stream arc should be 6 to 12 inches diameter, depending on unit type and location, and not blocked by any objects.

9. Nozzle angle.

Nozzles shall angle forward 30-45º above horizontal for eye and face hose type units, or be so angled forward or toward each other if plumbed bowl units.

10. Signage.

Eyewash signage shall be provided and mounted prominently near the eyewash, visible from any angle of approach.

F. 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.

1. Labeling and required approvals.

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

2. Retention basin.

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

3. Cabinet doors.

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

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.

G. Corrosives Storage Cabinets

1. Cabinet installation.

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

2. Cabinet materials.

Cabinets shall be made of non-corroding materials.

3. Catch pans.

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

4. Cabinet labeling.

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

5. Cabinet venting (see section V1 - F.4 above)

H. Gas Cylinders Storage

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 used area as specified by code. These devices shall be capable of alarming to warn area occupants of a gas venting episode, of if the oxygen level in the area is diminished. 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.

2. Securing of cylinders.

Laboratory design shall make provision to individually secure all compressed gas cylinders with appropriate restraints located at least 3 feet from the floor. Cylinder connection closets are recommended for compatible compressed gases.

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.

APPENDIX

LABORATORY PROJECT CHECKLIST

01. __ Laboratory aisles are at least 4 feet in width. [II-A-1]
02. __ Clear wall space at doors is at least 2 feet. [II-A-2]
03. __ Cabinets and shelving are not located to impede sprinkler head water flow. [II-A-3]
04. __ Air supply vents are not close to fume hoods and biosafety cabinets. [II-B-1]
05. __ Chemical storage rooms have an independent air supply. [II-B-2]
06. __ Disability (ADA) design considerations are taken into account. [III-B]
07. __ Cabinet, countertop, and fume hood materials are appropriate for uses. [IV-B-3 / V-H]
08. __ Cabinetry meets the size criteria. [IV-A & B]
09. __ Sliding doors have required stops. [IV-A-4-b]
10. __ Reagent shelving is 5 feet from the floor. [IV-A-6-b]
11. __ Reagent shelving has ½-inch retaining lips. [IV-A-6-a]
12. __ Doors and drawers do not stick when opened and closed. [IV-B-2]
13. __ Panels are all in place and properly secured. [IV-B-2 / V-G-6-a]]
14. __ Service fixtures are properly positioned and secured in place [IV-D / V-G-4]]
15. __ Service fixtures, lab and fume hoods, are properly identified and color-coded. [IV-C-1]
16. __ Electrical service fixtures of required types have proper covers. [IV-C-10-c / IV-D]
17. __ Electrical outlets are properly wired and grounded. [IV-D]
18. __ Electrical outlets are GFCI type if within 6 feet of a water source. [IV-C-10-c / V-G-4-e]
19. __ Panel circuits, including GFCI, are properly identified. [IV-C-11 / V-G-4-f]
20. __ Water service fixtures have vacuum breakers and cut-off valves. [IV-C-2]
21. __ Water service fixture valves turn on/off in required direction. [IV-C-2]
22. __ Special water service installations have self-closing valves. [IV-C-4]
23. __ Cup sinks have strainers secured in place. [IV-C-6-b]
24. __ Fume hoods are UL approved and pass the ASHRAE 110 test. [V-G-1]
25. __ Fume hoods are not located near doors or in a main laboratory aisle. [V-E]
26. __ Fume hood superstructures are secured to countertop cabinet. [V-I-1]
27. __ Fume hoods 5 feet or wider have service fixtures (on each side). [V-G-4-b]
28. __ Fume hood sashes move up and down easily and stay where stopped. [V-G-7-c]
29. __ Fume hood airfoil is secured to hood structure. [V-G-8-a]
30. __ Fume hood light fixture has twin lamps and is properly installed and secured. [V-I-2-b]
31. __ Fume hood light fixture has a switch on the hood face and works properly. [V-G-4-g]
32. __ Fume hood low airflow alarm is installed, working, and calibrated. [V-G-5 / V-J-4]
33. __ Fume hood low airflow alarm activates if exhaust airflow falls below 80 fpm. [V-G-5-k]
34. __ Fume hood low airflow alarm activates when sash opening exceeds 18 inches. [V-G-5-k]
35. __ Fume hood low airflow alarm signals both visually and audibly when activated. [V-G-5-e/g]
36. __ Fume hood low airflow alarm audible signal is mutable during alarm sequence. [V-G-5-g]
37. __ Fume hood service fixtures are on a common vertical center line. [V-G-4-a]
38. __ Fume hood water service fixtures are located directly over cup sinks. [V-G-4-c]
39. __ Fume hood baffles (if supplied) open and close from the hood exterior. [V-G-9-c]
40. __ Fume hood sash stops are installed and set at 18 inches from the work surface. V-G-7-f]
41. __ Fume hood nameplate is provided, meeting criteria for perchloric acid hoods. [V-G-10-a]
42. __ Fume hood exhaust duct connections meet installation criteria and are secured. [V-I-3-i/j]
43. __ Exhaust duct dampers and valves are accessible for adjustment or service work.[V-I-3-h]
44. __ Hood duct connectors are labeled to identify the hood they serve. [V-I-3-v / V-L-1-e]
45. __ Fume hood ducting is properly connected to an exhaust fan (if not manifolded). [V-I-3-j]
46. __ Fume hood exhaust fans are permanently identified as to the hoods they serve. [V-I-3-w]
47. __ Fume hood exhaust ducts are at least 10 feet above the roof. [V-I-3-s]
48. __ Fume hood exhaust ducts are well away from air intakes. [V-I-3-r]

49. __ Fume hood exhaust stack airflow meets required discharge velocity). [V-i-3-q]
50. __ Fume hood fan drive and motor units are properly guarded. [V-I-4-b]
51. __ Manifold ducts and connectors meet the design criteria in this document. [V-L-2]
52. __ Hood airflow is 100 fpm with sash set at 18 inches above work surface. [V-B-1 / V-K-2-c]
53. __ Fume hood sound level (at sash area) does not exceed 63 decibels (dBA). [V-J-3]
54. __ Fume hoods have operating instructions/low airflow alarm instructions. [V-G-11 / V-G-5-c]
55. __ Laboratories are pressurized negatively to surrounding space. [I-H]
56. __ Test and balance work has been completed, verifying proper installations. [I-E-2 / V-K-2]
57. __ Back-up exhaust fan power kicks in within 3 seconds of a manifold fan failure. [V-L-3-c]
58. __ Perchloric acid hoods have a connected, identified, working wash-down system. [V-I-3-k]
59. __ BSCs provided are located away from air supply vents, aisles, and doors. [II-B-1 / VI-C-2]
60. __ BSCs provided have at least 6 inches side and 18 inches top clearance. [VI-C-2]
61. __ BSC wrappings are essentially left in place until dusty area work is completed. [VI-C-4]
62. __ Required BSC service fixtures are installed and work properly. [VI-C-3]
63. __ BSCs are certified by an accredited certifier. [VI-C-5]
64. __ Safety showers are located within a 10 second walking time of lab hazard areas. [IV-D-1]
65. __ Safety showers are located at least 4 feet from walls (preferably near a sink). [VI-D-3]
66. __ Safety showers are located at least 6 feet from electrical sources. [iV-D-4]
67. __ Safety shower heads are installed 4 inches below ceiling. [VI-D-3]
68. __ Safety shower valve rods or handles are within easy reach of deluge area. [VI-D-2]
69. __ Safety showers have an identified in-line shut-off valve (usually above ceiling). [VI-D-5]
70. __ Screen filters in the water supply line (if installed by manufacturer) are removed. [VI-D-6]
71. __ Safety shower water flow is at least 20 gpm. [VI-D-10]
72. __ Safety shower water flow stops dripping within 1 minute of shut-off. [VI-D-11]
73. __ Safety shower signage is installed, visible from any direction. [VI-D-8]
74. __ Eyewashes are plumbed into the cold water line at or near a major sink. [VI-E-1]
75. __ Eyewashes have twin-stream nozzles, properly anchored to maintain position. [VI-E-3]
76. __ Eyewash nozzle filters are not installed until water supply lines are flushed out. [VI-E-4]
77. __ Eyewash water flow is at least 3 gpm. [VI-E-7]
78. __ Eyewash water pressure is gentle (adjusted to criteria guideline). [VI-E-8]
79. __ Eyewash water stream is not blocked by cabinetry or other equipment. [VI-E-5 / VI-E-8]
80. __ Eyewash valve handle remains on when activated. [VI-E-6]
81. __ Eyewash signage is installed, visible from any direction. [VI-E-10]
82. __ Flammables cabinets provided are labeled and have UL and FM approvals. [VI-F-1]
83. __ Flammables cabinets provided have positive latching, self-closing doors. [VI-F-3]
84. __ Flammables cabinets provided are not vented. Vent caps are in place. [VI-F-4-a]
85. __ Flammables cabinets provided have a retention basin for leak containment. [VI-F-2]
86. __ Corrosives cabinets are provided where needed. [VI-G-1]
87. __ Corrosives cabinets provided are non-corroding and have spill containment. [VI-G-2&3]
88. __ Compressed gas cylinder storage areas and restraints are provided. [VI-H-2]
89. __ Compressed gas cylinder closets have required venting. [VI-H-1-b]
90. __ Vented gas cylinder closets have gas sensing devices and an alarm. [IV-H-1-c]
91. __ Compressed gas supply lines are properly identified. [VI-H-3]
92. __ Damaged or missing laboratory equipment or parts have been identified and replaced.
93. __ Water supply and drain connections are tested as correctly installed and working.
94. __ Any plumbing leaks (water, drains, gases) are repaired (all fixtures).
95. __ Laboratory wall, corner, and surface moldings are all in place and secured.

INSTITUTION GUIDELINES FOR LABORATORY SAFETY EQUIPMENT (Recommended Practices)

G-I. FUME HOODS

A. Hood identification

It is recommended that all 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.

B. Hood certification

Fume hoods should receive annual certification to assure they are performing properly. If airflow is found below the acceptable range (80-120 fpm with sash open at 18 inches), hoods should be removed from service until required airflow is re-established. Other problems noted should be reported for correction when discovered.

C. Hood use

a. 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.

b. Large equipment used in a hood should be raised an inch or more off the hood base to allow airflow under it.

c. When using a perchloric acid hood, the wash-down system should be used prior to using perchloric acid within the hood.

d. Spills and residues within a hood should be cleaned up promptly.

D. Hood storage

a. Fume hoods shall not be used primarily for the storage of chemicals or for evaporating chemicals from containers.

b. 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.

c. Contents within a hood should not block rear openings at any level. Baffles should not be completely closed off.

G-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, 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.

G-III. EMERGENCY SAFETY SHOWERS

A. Annual Flushing

All safety showers should be flushed clean at least annually.

B. Tagging

Safety showers should be tagged for continuous proof of servicing.

G-IV. EYEWASH UNITS

A. Annual Check

Eyewash units should be checked annually for proper valve operation, nozzle restrictions, filters condition and pressure adjustment.

B. Weekly Flushing

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

C. Tagging

Eyewash units should be tagged for continuous proof of service.

D. Filters Replacement

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

G-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.

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.

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.

Set-back – A reduced energy setting typically used when areas are unoccupied.

Special purpose – A hood system of atypical design for special operations and/or apparatus.

Test and Balance – A adjustment procedure to HVAC systems and 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.

ACRONYMS

ADA – Americans with Disabilities Act **http://www.usdoj.gov/crt/ada**

AIHA - American Industrial Hygiene Association **http://www.aiha.org/Content**

ANSI – American National Standards Institute **http://www.ansi.org**

ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers **http://www.ashrae.org**

BoR – USG – Board of Regents – University System of Georgia **http://www.usg.edu/ehs/**

BSC – Biological safety cabinet

CDC – Centers for Disease Control and Prevention **http://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)

LFB – Laminar flow bench

NESHAP – National Emission Standards for Hazardous Air Pollutants

NFPA – National Fire Prevention Association **http//www.nfpa.org**

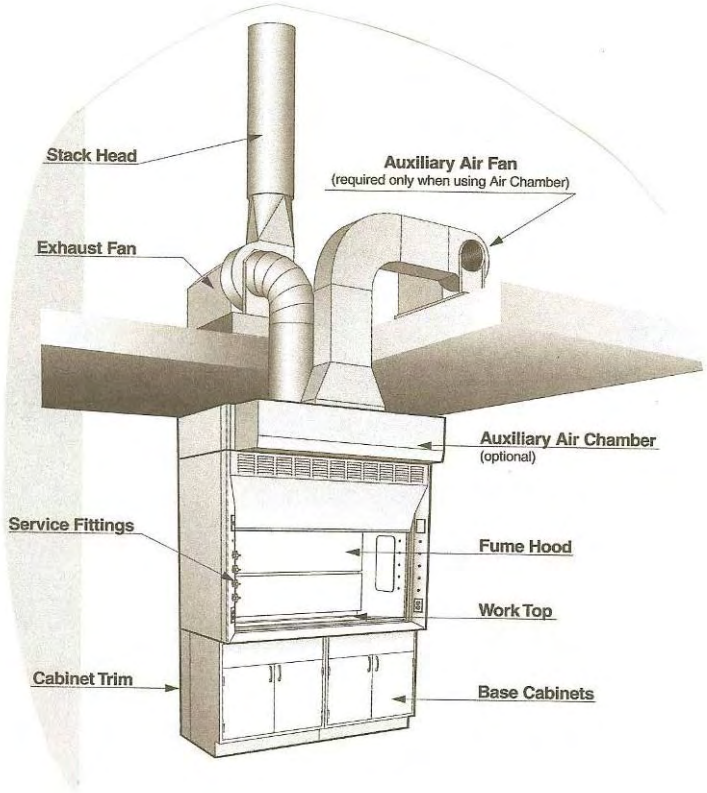
NSF – National Sanitation Foundation (International) **http//www.nsf.org**

SEFA - Scientific Equipment and Furniture Association **http//www.sefalabs.com/**

T&B – Test and balance (building air systems)

UL – Underwriters Laboratories **http//www.ul.com**

USDHHS – U.S. Department of Health & Human Services


Stack Head
Auxiliary Air Fan
(required only when using Air Chamber)
Exhaust Fan
Auxiliary Air Chamber
(optional)
Service Fittings
Fume Hood
Work Top
Cabinet Trim
Base Cabinets