Section 1.1: VENTILATION

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A. Regulations, Standards and References

Regulations:

California Code of Regulations (CCR), Title 8, Section 5154.1,
Ventilation requirements for laboratory type hood operations

California Code of Regulations, Title 8, Section 5209, Carcinogens

Code of Federal Regulation (CFR) 10, Parts 20 and 35

National Fire Protection Association (NFPA) Handbook 45,
Standard on Fire Protection for Laboratories Using Chemicals

National Fire Protection Association (NFPA) Handbook 99
Standard for Health Care Facilities

Consensus Standards and References:

American National Standards Institute (ANSI), Z358.1
Emergency Eyewash and Shower Equipment

American National Standard for Laboratory Ventilation (ANSI/AIHA Z9.5)

American National Standard for Thermal Environmental Conditions for Human Occupancy (ANSI/ASHRAE 55-1992)

The CalDAG – California Disabled Accessibility Guidebook

"Guide for the Preparation of Applications for Medical Programs" (RH 2010 4/90) (not formally adopted) (DOHS 2010)

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

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

B. Scope

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

C. General Ventilation Considerations

1. **The room should have mechanically generated supply air and exhaust air. All lab rooms shall use 100% outside air and exhaust to the outside. There shall be no return of fume**

hood and laboratory exhaust back into the building.

Good Practice per Stanford University EH&S
Prudent Practices in the Laboratory 8.C, 8.D
CCR, Title 24, Part 3, Section 505.3
NFPA 45, Chapter 6-4.1
ANSI/AIHA Z9.5, 4.10.3

The air balance of the room cannot be adjusted unless there is mechanically generated supply and exhaust air.

2. Mechanical climate control should be provided.

Good Practice per Stanford University EH&S

- **Per ASHRAE 55-1992, comfortable temperature range are defined as follows:** <u>Winter</u>**: 69-76 °F (at 35% RH);** <u>Summer</u>**: 73-79 °F (at 60% RH)**
- Electrical appliances often exhaust heat into a room (e.g., REVCO freezer, incubator, and autoclave). Failure to take this effect into consideration may result in an artificially warm working environment. Windows must <u>not</u> be opened for a cooling effect since the room air balance will be altered. A cool room must not be heated with a portable heater that may be a fire hazard.

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

Good Practice per Stanford University EH&S

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

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

Design and Construction of Inside Storage Rooms, General Industry Standard 29 CFR 1910.106, page 144, OSHA 2206, Nov. 7, 1987 (OSHA, 1987).
AHSRAE Handbook, Chapter 13

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

5. Laboratories must be maintained under negative pressure in relation to the corridor or other less hazardous areas. Clean rooms requiring positive pressure should have entry vestibules provided with door-closing mechanisms so that both doors are not open at the same time. Consult with SU Fire Marshal for design details.

ANSI/AIHA Z9.5 – 1992, 4.11.4-4.11.5

As a general rule, airflow should be from areas of low hazard, unless the laboratory is used as a clean or sterile room.

6. **Where appropriate, general ventilation systems should be designed, such that, in the event of an accident, they can be shut down and isolated to contain radioactivity.**

   Good Practice per Stanford University

7. **The air velocity volume in each duct should be sufficient to prevent condensation or liquid or condensable solids on the walls of the ducts.**

   Good Practice per Stanford University

   The ACGIH Industrial Ventilation handbook (22nd edition) recommends a velocity of 1000-2000 fpm.

8. **Fume hoods should not be the sole means of room air exhaust. General room exhaust outlets shall be provided where necessary to maintain minimum air change rates and temperature control.**

   Good Practice per Stanford University

9. **Operable windows should be prohibited in new lab buildings and should not be used on modifications to existing buildings.**

   Good Practice per Stanford University

10. **Local exhaust ventilation (e.g., "snorkels" or "elephant trunks"), other than 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 equipment which can produce potentially hazardous air pollutants. 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.**

    ACGIH, Industrial Ventilation: A Manual of Recommended Practice, 23rd edition, or latest edition

    Enclosure minimizes the volume of airflow needed to attain any desired degree of containment control. This reduces fan size, motor horsepower, make up air volume, and make up air conditioning costs.

11. **Hoods should be labeled to show which fan or ventilation system they are connected to.**

    Good Practicer per Stanford University

12. **No laboratory ventilation system ductwork shall be internally insulated. Sounds**

baffles or external acoustical insulation at the source should be used for noise control.

Good Practice per Stanford University

Fiberglass duct liner deteriorates with aging and sheds into the space resulting in IAQ complaints, adverse health effects, maintenance problems and significant economical impact. Glass wool and refractory ceramic fibers are now rated as possible carcinogens by the National Toxicology program.

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

NFPA 45, Chapter 6-4.3

D. Negative Pressurization

1. **Airflow shall be from low hazard to high hazard areas.**

Good Practice
CDC-NIH Biosafety in Microbiological and Biomedical Laboratories
Prudent Practices in the Laboratory 8.C, 8.D
NFPA 45,6.4.4

Anterooms may be necessary for certain applications, such as clean rooms or tissue culture rooms. Potentially harmful aerosols can escape from the containment of the laboratory room unless the room air pressure is negative to adjacent non-laboratory areas.

It is recommended that laboratories should contain a fully integrated laboratory control system to control the temperature, ventilation rate and room pressurization. The control system should constantly monitor the amount of supply and exhaust air for the laboratory rooms and regulate the flow to maintain a net negative pressurization.

2. **An adequate supply of make up air (90% of exhaust) should be provided to the lab.**

Good Practice per Stanford University

3. **An air lock or vestibule may be necessary in certain high-hazard laboratories to minimize the volume of supply air required for negative pressurization control. These doors should be provided with interlocks so that both doors cannot open at the same time.**

Good Practice per Stanford University

4. **A corridor should not be used as a plenum.**

Good Practice per Stanford University

E. Supply Air Arrangements

1. **Room air currents at the fume hood should not exceed 20% of the average face velocity to ensure fume hood containment.**

Prudent Practices in the Laboratory 8.C
Good Practice per Stanford University
ANSI Z9.5-2003

Z9.5-2003 allows air velocities up to 50 fpm, but lower room air velocities around hoods cause less interference with the operation of the hood. Make up air should be injected at low velocity through an opening with large dimensions to avoid creating jets of airflow. An alternative is to direct air towards a ceiling that will allow the air velocity to decrease by the time it approaches a hood.

2. **Make-up air should be introduced at opposite end of the laboratory room from the fume hood(s) and flow paths for room HVAC systems shall be kept away from hood locations, to the extent practical.**

NFPA 99, Chapter 5-4.3.2
NFPA 45, Chapter 6-3.4 and 6-9.1
NIH Design Policy and Guidelines, Research Laboratory, 1996, D.7.7
ANSI Z9.5-2003

Air turbulence defeats the capability of hoods to contain and exhaust contaminated air.

3. **Make-up air shall be introduced in such a way that negative pressurization is maintained in all laboratory spaces and does not create a disruptive air pattern.**

Good Practice per Stanford University

4. **Cabinetry or other structures or equipment should not block or reduce effectiveness of supply or exhaust air.**

Good Practice per Stanford University

5. **Supply system air should meet the technical requirements of the laboratory work and the requirements of the latest version of ASHRAE, Standard 62, Ventilation for Acceptable Indoor Air Quality.**

Good Practice per Stanford University

F. Fume Hood Location

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

   NFPA 99, Chapter 5-4.3.2
   NFPA 45, Chapter 6-3.4 and 6-9.1

Air turbulence affects the capability of hoods to exhaust contaminated air. Eddies are created by people passing by and by other sources of air currents.

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

NFPA 45, Chapter 6-9.2
NFPA 45, Chapter 3-4.1(d)
NFPA 99, Chapter 5-4.3.2
ANSI/AIHA Z9.5, 5.4

A fire hazard or chemical release incident, both of which may start in a fume hood, can block an exit rendering it impassable. A fire or explosion in a fume hood located adjacent to a path of egress could trap someone in the lab.

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

NFPA 45, Chapter 6-9.3

Materials splattered or forced out of a hood could injure a person seated across from the hood.

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

CCR, Title 8, Section 5162
ANSI Z358.1

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

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

The CalDAG – California Disabled Accessibility Guidebook

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

G. <u>Approved Equipment</u>

1. **All fume hoods shall meet the requirements of CCR, Title 8, Sections 5141.1, 5209, and 5143 in addition to NFPA 45, Standard on Fire Protection For Laboratories Using Chemicals.**

H. Fume Hood and Local Exhaust Ventilation Selection/Types

1. General: Factors to consider when selecting a fume hood:

- **Room size (length x width x height)**
- **Number of room air changes**
- **Lab heat load**
- **Types of materials used**
- **Linear feet of hood needed based on**
  - ✓ *number of users/hood*
  - ✓ *frequency of use*
  - ✓ *% of time working at hood*
  - ✓ *size of apparatus to be used in hood, etc.*

  A facility designed for intensive chemical use should have at least 2.5 linear feet of hood space per student.

Good Practice per Stanford EH&S

Evaluating the operational and research needs of the users will ensure that the appropriate type and number of hoods are integrated into the laboratory.

2. Constant Volume Hoods

These hoods permit a stable air balance between the ventilation systems and exhaust by incorporating a bypass feature. If bypass is 100% this allows a constant volume of air to be exhausted through the hood regardless of sash position.

3. Variable Air Volume (VAV) fume hoods

These hoods maintain constant face velocities by varying exhaust volumes in response to changes in sash position. Because only the amount of air needed to maintain the specified face velocity is pulled from the room, significant energy savings are possible when the sash is closed. However, since these hoods cost more than up front and more maintenance, effective sash management (e.g., pull sash closed when not using hood) is necessary.

3. Supply or auxiliary air hoods

These hoods are not permitted, unless an exception is granted by EH&S.

Good Practice per Stanford University EH&S

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

5. **Ductless Fume Hoods: Portable, non-ducted fume hoods are generally not permitted; however, a portable hood may be used for limited applications (e.g., used inside of an existing hood for a special application, such as odor control). Such applications must be reviewed and approved by EH&S on a case-by-case basis.**

ANSI/AIHA Z9.5, 5.16

Portable hoods often do not meet the regulatory airflow requirements. Filters used with these units must be changed frequently and vary in filtration effectiveness from chemical to chemical. Experience has demonstrated that an OSHA compliance officer may require quarterly monitoring of hood exhaust to demonstrate the effectiveness of the filtration in the given application and the corresponding protection of the workers occupying the space. These hoods are often misused.

6. **Perchloric/Hot Acid Hoods:**

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

NFPA 45, Chapter 6-11.1

Heated perchloric acid will give off vapors that can condense and form explosive perchlorates. Limited quantities of perchloric acid vapor can be kept from condensing in laboratory exhaust systems by trapping or scrubbing the vapors at the point of origin.

b) **Perchloric acid hoods and exhaust duct work shall be constructed of materials that are acid resistant, nonreactive, and impervious to perchloric acid.**

8 CCR 5154.1(e)(7)
NFPA 45, Chapter 6-11.2
ANSI/AIHA Z9.5

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

located within the duct work.

NFPA 45, Chapter 6-11.3

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

NFPA, Chapter 6-11.4

e) **Sealants, gaskets, and lubricants used with perchloric acid hoods, duct work, and exhaust systems shall be acid resistant and nonreactive with perchloric acid.**

NFPA 45, Chapter 6-11.5
ANSI/AIHA Z9.5

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

8 CCR 5154.1(e)(7)
NFPA 45, Chapter 6-11.6
ANSI/AIHA Z9.5

Perchloric acid is a widely used reagent know to produce flammable or explosive reaction products; hence, the need to have wash down capabilities after each use to remove residues. A watertight surface will contain any chemical spills or leaks from leaking to underneath hood.

g) **Spray wash-down nozzles shall be installed in the ducts no more than 5 ft. apart. The ductwork shall provide a positive drainage slope back into the hood. Ductwork shall consist of sealed sections, and no flexible connectors shall be used.**

NFPA 45, Chapter 6-11.4

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

Good Practice per Stanford University EH&S

Access for cleaning is an important design feature.

i) The hood baffle shall be removable for inspection and cleaning.

NFPA 45, Chapter 6-11.7

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

ANSI/AIHA Z9.5

7. Radioactive Material Use

a) Laboratory hoods in which radioactive materials are handled shall be identified with the radiation hazard symbol.

NFPA, Chapter A-6-12.1

b) Fume hoods intended for use with radioactive isotopes must be constructed of stainless steel or other materials that will not be corroded by the chemicals used in the hood.

NCRP Report # 8
NFPA 99, Chapter 5-4.3.3
DOHS2010
CRC Handbook of Laboratory Safety, 4th Ed.

c) The interior of all radioisotope hoods must have coved corners to facilitate decontamination.

NFPA 99, Chapter 5-4.3.3
DOHS2010
CRC Handbook of Laboratory Safety, 4th Ed.
IAEA, Safe Handling of Radionuclides

Cracks and crevices are difficult to decontaminate.

d) The hood exhaust may require filtration by HEPA or Charcoal HEPA filters. Where such is the likelihood, the hood must have a bag-out plenum for mounting such filters and fan capacity for proper operation of the hood with the filter installed. The most appropriate location for the plenum is near the exhaust port of the fume hood (i.e., proximal to the hood).

NFPA 99, Chapter 5-4.3.3
DOHS2010
CRC Handbook of Laboratory Safety, 4th Ed.
IAEA, Safe Handling of Radionuclides

e) Hoods used for radioactivity should have sashes with horizontal sliding glass panels mounted in a vertical sash.

NFPA 99, Chapter 5-4.3.3
DOHS2010
10 CFR 20: Appendix B
CRC Handbook of Laboratory Safety, 4th Ed.
IAEA, Safe Handling of Radionuclides

f) The cabinet on which the hood is installed shall be adequate to support shielding for the radioactive materials to be used therein.

NFPA 99, Chapter 5-4.3.3
DOHS2010
10 CFR 20: Appendix B
CRC Handbook of Laboratory Safety, 4th Ed.
IAEA, Safe Handling of Radionuclides

g) In general, glove boxes with HEPA filtered exhausts shall be provided for operations involving unsealed radioactive material that emit alpha particles. Consult with the Radiation Safety Program for specific requirements.

NFPA 99, Chapter 5-4.3.3
DOHS2010
10 CFR 20: Appendix B
CRC Handbook of Laboratory Safety, 4th Ed.
IAEA, Safe Handling of Radionuclides

8. American with Disabilities Act (ADA) Hoods: Must consult with Stanford University's ADA Compliance Office regarding the number lab hoods to install in facilities, which are accessible to and usable by individuals with disabilities – recommend minimally one ADA hood per laboratory floor. These hoods must provide appropriate worksurface heights, knee clearances, reach to controls, etc. to individuals in wheelchairs.

The CalDAG – California Disabled Accessibility Guidebook

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

9. Glove Boxes: Glove boxes (positive and negative) must meet the type, design and construction of requirements ANSI/AIHA Z9.5-1992, 5.14.

ANSI/AIHA Z9.5

10. Walk-in Fume Hoods: These hoods must meet the type, design and construction requirements of ANSI/AIHA Z9.5-1992, 5.13.

ANSI/AIHA Z9.5

11. Special Purpose Hoods: These hoods include enclosures for operations for which

other types of hoods are not suitable (e.g., enclosures for analytical balances, histology processing machines, special mixing stations, evaporation racks). These hoods must be designed per ANSI Z9.2 and the Industrial Ventilation manual.

ANSI/AIHA Z9.5
Industrial Ventilation - A Manual of Recommended Practice (ACGIH)

I. Fume Hood Labeling

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

   NFPA 45, Chapter 6-12.1

2. **A label must be affixed to each hood containing the following information from the last inspection:**

   a. **certification date due**
   b. **average face velocity**
   c. **inspector's initials**

   NFPA 45, Chapter 6-12.2 {NOTE: This code sites slightly different information for the label. Stanford determined it was appropriate to create a label with the above information.}

J. Fume Hood Construction, Installation & Performance

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

   Good Practice per Stanford University EH&S

   Recommend that solvent storage not be located under the laboratory fume hood, as this location is where fires are most likely to occur in laboratories.

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

   Good Practice per Stanford University EH&S

   This material affords good, general corrosion, impact and vibration resistance.

3. **Fume hood interior surfaces shall be constructed of corrosion resistant, non-porous, non-combustible materials such as type 316 stainless steel, and should be smooth and impermeable, with rounded corners. These materials shall have a flame spread index of 25 or less when tested in accordance with NFPA method 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.**

NFPA 45, Chapter 6-8.1.1, 6-11.2, 6-11.6
NFPA 99, 5-4.3.3
ANSI/AIHA Z9.5-1992, 5.12

Type 316 stainless steel (SS 316) is specified to avoid corrosion, thereby extending fume hood life. Splashes of liquid containing radioactive materials can be easily cleaned when hoods are constructed of non-porous materials such as stainless steel. Perchloric acid digestion over time may result in the condensation and consequential formation of perchlorate crystals, which in large quantities pose an explosion hazard, especially if combined with organic chemical condensate.

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

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

NFPA 45, Chapter 6-9.1.3
ANSI/AIHA Z9.5, 5.2

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

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

ANSI/AIHA Z9.5, 5.2

The air foil at the front of the hood floor assures a good sweep of air across the working surface toward the back of the hood. This minimizes the generation of turbulents or eddy currents at the entrance to the hood.

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

ANSI/AIHA Z9.5, 5.2

Locating the slots in this manner will attain reasonably uniform face velocity under different conditions of hood use as related to heat sources, size, and configuration of equipment in hood.

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

Good Practice per Stanford University EH&S

A fume hood exhausts a substantial amount of air. For this reason, additional make up air must be brought into the room to maintain a proper air balance.

9. Face Velocity:

Laboratory fume hoods shall provide a minimum average effective face velocity of 100 feet per minute (fpm), with a minimum of 70 fpm at any point.

Ref: 8 CCR 5154.1(c)

10. Certification: See Stanford University's laboratory fume hood performance and certification protocol at:
http://www.stanford.edu/dept/EHS/prod/researchlab/lab/Laboratory_Fume_Hoods.pdf

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

CCR, Title 8, Section 5154.1(e)(1)

12. An airflow indicator shall be provided and located so that it is visible from the front of the fume hood.

CCR, Title 8, Section 5154.1(e)(3)
NFPA 45, Chapter 6-8.7.1
ANSI/AIHA Z9.5-1992, 5.8

Follow manufacturer's procedures for calibration of air flow indicator during installation. Follow manufacturer's schedule for periodic calibration and maintenance parameters thereafter. Performance criteria for various airflow indicators are as follows:

- Kim Wipes: Shows inward flow.
- Magnahelic Gauges: Mark on gauge inches water read when average face velocity at 100 fpm.
- FPM Readout: Average readout is 100 fpm.
- Audio/Visual Alarms: Go into alarm mode if average face velocity drops to 80 fpm.

13. Baffles shall be constructed so that they may not be adjusted to restrict the volume of air exhausted through the laboratory hood.

NFPA 45, Chapter 6-8.1.2

14. Fans should run continuously without local control from hood location and independently of any time clocks.

Good Practice per Stanford University EH&S

If users have ability to shut off hoods or control their use with a time clock, there is a potential for users to conduct research in a hood that is not operating.

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

NFPA 45, Chapter 6-8.5.1

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

NFPA 99, Chapter 5-4.3.6

17. **Laboratory hoods shall not have an on/off switch located in the laboratory. Exhaust fans shall run continuously without direct local control from laboratories.**

Good Practice per Stanford University

18. **Drying ovens shall not be placed under fume hoods.**

Good Practice per Stanford University

K. Fume Hood Power and Electrical

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

Good Practice per Stanford University EH&S

This backup power source will ensure that chemicals continue to be exhausted. EH&S recognizes that it may not be practical to provide emergency power sufficient to maintain fume hood functioning at normal levels but recommends an emergency supply of at least half of the normal airflow.

2. **Emergency power circuits should be available for fan service so that fans will automatically restart upon restoration after a power outage** and supply at least half of the normal airflow

Good Practice per Stanford University EH&S

Continual fan service will ensure that hazardous materials are exhausted continually

3. **Momentary or extended losses of power shall not change or affect any of the control system's setpoints, calibration settings, or emergency status. After power returns, the system shall continue operation, exactly as before, without the need for any manual intervention. Alarms shall require manual reset, should they indicate a potentially hazardous condition.**

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

NFPA 99, Chapter 5-4.3.4

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

NFPA 45, Chapter 6-8.4.1

Locating services, controls, and electrical fixtures external to the hood minimizes the potential hazards of corrosion and arcing.

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

NFPA 45, Chapter 3-6

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

Good Practice per Stanford University EH&S

Fluorescent bulbs radiate less heat than conventional bulbs while maintaining a safe and illuminated work area inside the hood.

8. **The valves, electrical outlets and switches for utilities serving hoods should be placed at readily accessible locations outside the hood. All shutoff valves should be clearly labeled. Plumbing (e.g., vacuum lines) should exit the sides of the fume hood and not the bench top.**

NFPA 45, Chapter 6-8.5.1
NFPA 99, Chapter 5-4.3.6 (Health Care)

Good Practice per Stanford University

L. Sashes

1. **Hoods shall have transparent movable sashes constructed of shatter-resistance, flame resistant material and capable of closing the entire front face.**

   ANSI/AIHA Z9.5-2003,
   8 CCR 5154.1(c)
   Good Practice per Stanford University

2. **Vertical-rising sashes are preferred. If horizontal sashes are used, sash panels (horizontal sliding) must be 12 to 14 inches in width.**

   Good Practice per Stanford University

   Sashes may offer extra protection to lab workers since they can be positioned to act as a shield.

3. **A force of five pounds shall be sufficient to move vertically and/or horizontally moving doors and sashes.**

   ANSI/AIHA Z9.5-2003, 3.1.1

M. Ducting

1. **Hood exhausts should be manifolded together except for:**
   - **Perchloric/hot acid hoods**
   - **hoods with washdown equipment**
   - **hoods that could deposit highly hazardous residues on the ductwork**
   - **exhaust requiring HEPA filtration or other special air cleaning**
   - **situations where the mixing of exhausted materials may result in a fire, explosion, or chemical reaction hazard in the duct system**

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

   CCR, Title 8, Section 5143
   NFPA 45

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

ANSI/AIHA Z9.5-1992, 6.1

Liquid pools and residue buildup which can result from condensation may create a hazardous condition if allowed to collect.

3. **Ducts exhausting air from fume hoods should be constructed entirely of non-combustible material. Gaskets should be resistant to degradation by the chemicals involved and fire resistant.**

NFPA 45, Chapter 6-5.1

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

NFPA 45, Chapter 6-10

Fire dampers are not allowed in hood exhaust ducts. Normal or accidental closing of a damper may cause an explosion or impede the exhausting of toxic, flammable, or combustible materials in the event of a fire.

N. <u>Exhaust</u>

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

Good Practice per Stanford University EH&S

Any other type of fan orientation increases the fan work load and increases the risk of exhaust emission re-entrainment.

2. **Hood exhaust stacks shall extend at least 7 feet above the roof. Discharge shall be directed vertically upward.**

CCR, Title 8, Section 5154.1(e)(4)(D)

If parapet walls are present, EHS recommends that stacks extend at least 2 feet above the top of a parapet wall or at least 7 feet above the roof, whichever is greater.

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

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

CCR, Title 8; Section 5154.1(e)(4)

SCCo Toxic Gas Ordinance No. NS-517.44

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

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

ANSI Z..95-2003, 5.3.5
Good Practice per Stanford University EH&S

Strobic-type exhaust fans may be used to address exhaust velocity needs.

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

CCR, Title 8; Section 5154.1(e)(4)

6. Fume hood exhaust <u>is not</u> required to be treated (e.g., filtered or scrubbed) except...

a. ...when one of the following substances is used with a content greater than the percent specified by weight or volume:

Chemical	**CAS Reg #**	**Percent**
2-Acetylaminofluorene	**53963**	**1.0**
4-Aminodiphenyl	**92671**	**0.1**
Benzidine (and its salts)	**92875**	**0.1**
3,3'-Dichlorobenzidine	**91941**	**1.0**
4-Dimethylaminoazobenzene	**60117**	**1.0**
alpha-Naphthylamine	**134327**	**1.0**
beta-Naphthylamine	**91598**	**0.1**
4-Nitrobiphenyl	**92933**	**0.1**
N-Nitrosodimethylamine	**62759**	**1.0**
beta-Propiolactone	**57578**	**1.0**
bis-Chloromethyl ether	**542881**	**0.1**
Methyl chloromethyl ether	**107302**	**0.1**
Ethyleneimine	**151564**	**1.0**

CCR, Title 8, Section 5209(b)11

1,2-Dibromo-3-Chloropropane
Asbestos
Vinyl Chloride
Acrylonitrile
Inorganic Arsenic
Ethylene Dibromide

Ethylene Oxide
Methylene Chloride

Good Practice

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

7. **Laboratory ventilation exhaust fans shall be spark-proof and constructed of materials or coated with corrosion resistant materials for the chemicals being transported. V-belt drives shall be conductive.**

NFPA 45

8. **Vibration isolators shall be used to mount fans. Flexible connection sections to ductwork, such as neoprene coated glass fiber cloth, shall be used between the fan and its intake duct when such material is compatible with hood chemical use factors.**

Good Practice per Stanford University

9. **Each exhaust fan assembly shall be individually matched (cfm, static pressure, brake horsepower, etc.) to each laboratory ventilation system.**

Industrial Ventilation Manual

10. **Exhaust fans shall be located outside the building at the point of final discharge. Each fan shall be the last element of the system so that the ductwork through the building is under negative pressure.**

8 CCR 5154.1(e)(6)
ANSI/AIHA Z9.5,

An exhaust fan located other than at the final discharge point can pressurize the duct with contaminated air. Fume hood ducts must be maintained under negative pressure.

11. **Fans shall be installed so they are readily accessible for maintenance and inspection without entering the plenum. If exhaust fans are located inside a penthouse, PPE needs for maintenance workers shall be considered.**

NFPA 45

O. <u>Wind Engineering</u>

1. **Wind engineering evaluations should be conducted for all wind directions striking all walls of a building where fume hood exhaust is likely to have significant ground level**

impact, or is likely to affect air intake for the same nearby buildings.

Good Practice per Stanford University

2. Emergency generator exhaust should be considered in the wind engineering study.

Good Practice per Stanford University

P. Noise

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

ANSI/AIHA Z9.5, 10
1991 HVAC Applications Handbook

Acceptable SPL may vary depending on the intended room use. A Noise Criteria (NC) curve of 55 dBA is generally adequate for a standard laboratory.

P. Specialty, Controlled Climate, and Cold Rooms

1. The issue of ventilation in cold rooms during periods of occupancy or for storage of hazardous materials must be addressed. EH&S should be consulted to review arrangements for providing fresh and exhaust air during periods of occupancy and for storage of hazardous materials or compressed gases.

Good Practice per Stanford University

Cold Rooms used only for the storage of non-hazardous materials do not require ventilation in addition to that specified by the manufacturer.

2. Specialty rooms, designed for human occupancy must have latches that can be operated from the inside to allow for escape.

Good Practice per Stanford University

3. Latches and frames shall be designed to allow actuation under all design conditions, such as freezing. Magnetic latches are recommended.

Good Practice per Stanford University

4. Doors of walk-in specialty rooms must have viewing windows and external light switches.

Good Practice per Stanford University

R. Lab Hood Commissioning

1. **Proper operation of fume hoods must be demonstrated by the contractor installing the fume hood prior to project closeout. The recommended containment performance test is ANSI/ASHRAE 110.**

   ANSI/AIHA Z9.5-2003, 6.3.7
   See certification requirements, Section G, #10.