UNIVERSITY OF WASHINGTON

ENVIRONMENTAL HEALTH AND SAFETY LABORATORY SAFETY DESIGN GUIDE-- LABORATORY VENTILATION

September 15, 2006

Environmental Health and Safety
UNIVERSITY OF WASHINGTON

III. LABORATORY VENTILATION

A. Scope

The purpose of this standard is to set forth the requirements for new or retrofit laboratory and fume-hood ventilation. This standard is to be considered the minimum requirement; more stringent requirements may be necessary depending on the specific laboratory function or contaminants generated.

B. General Laboratory Ventilation Design Issues

The primary function of a ventilation system is to provide a comfortable and safe breathing environment for all employees and the public. Careful planning, design, and maintenance of ventilation systems is critical for accomplishing these goals. EH&S shall approve any additional ventilation controls (e.g., local exhaust ventilation) needed to control hazardous chemical exposures. EH&S, (and Engineering Services for UW owned and operated facilities), shall agree with the design of the ventilation system. Any management approach that eliminates the process of mutual agreement risks mistakes that may be costly to live with and correct later.

1. All laboratory spaces shall have mechanically generated supply air and exhaust air. All laboratory rooms shall use 100% outside air and exhaust to the outside. There shall be no return of fume-hood or laboratory exhaust back into the building.

   Prudent Practices in the Laboratory 8.C, 8.D

2. There shall be ten air changes per hour of ventilation for laboratories. Room light switches shall not be used to control either hood exhaust flow rates or room air exchange rates. Additional exhaust/local ventilation may be needed contingent upon EH&S review.

3. Fume hoods should not be the sole means of room air exhaust. General room exhaust shall be provided where necessary to maintain minimum air change rates, good air mixing, and temperature control.

   Good Practice

   A minimum of 2.5 linear feet of hood should be provided for each worker for biochemical research. This should be adjusted up or down depending on the type of research being conducted.

4. The system shall have at least 10% excess capacity for future expansion.

5. The noise level in the general laboratory space should not exceed 55 dBA, consistent with good office design. This allows for easy verbal communication.

Good Practice

6. Operable windows are prohibited in laboratories of new buildings and should be avoided on modifications to existing buildings.

   Good Practice

7. Local exhaust ventilation (LEV) systems (e.g., "snorkels" or "canopy hood"), other than fume hoods, shall be designed to adequately control exposures to hazardous chemicals. This system is to be separate from the fume hood and general exhaust systems. The LEV system must be designed per the ACGIH Industrial Ventilation Manual or other professionally recognized design criteria.

   ACGIH, Industrial Ventilation: A Manual of recommended Practice, latest edition.

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

8. Airflow shall be from low hazard to high hazard areas.

   Good Practice

   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.

9. The laboratory control system shall ensure laboratory pressurization is maintained negative to adjacent non-lab areas by continuously comparing supply airflow and exhaust airflow. Provide an offset of 10% or 100 cfm – whichever is greater.

   Prudent Practices 8.D

   See item B.1 of this section about air change rates.

10. An adequate supply of makeup air (90% of the exhaust) shall be provided to the laboratory.

11. 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 shall be provided with interlocks so that both doors cannot open at the same time.

12. A corridor shall not be used as a plenum.

13. Cabinetry or other structures or equipment shall not block or reduce the effectiveness of supply or exhaust air.

    Good Practice

14. Supply system air shall meet the technical requirements of the laboratory work and the requirements of the latest version of the Washington State Indoor Air Quality Code.

    State Law

15. No laboratory ventilation system ductwork shall be internally insulated. Exceptions will be determined by EH&S and Engineering Services.

    Occupational Exposure, Toxic Properties, and Work Practices Guidelines for Fiberglass, AIHA

    Good Practice

    Fiberglass duct liners deteriorate with aging and shed into the space resulting in IAQ complaints, adverse health affects, maintenance problems and significant economical impact. The National Toxicology Program now rates glass wool and refractory ceramic fibers as possible carcinogens.

16. Cold rooms that are designed for occupancy of any duration must be ventilated; this is not required if they are for storage only and there is no chance of a hazardous atmosphere being created. Air supplied to the cold room must be dehumidified first to prevent condensation and resulting potential for biological growth. In some circumstances, low O2 / high CO2 / high contaminant concentration alarms have been considered in lieu of room ventilation.

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

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

19. Doors of walk-in specialty rooms shall have viewing windows and external light switches.

C. Fume Hood Exhaust System Design Criteria

1. If this is not a University owned facility, see the Appendix A at the end of this section for further design details of the FHES. If it is a University owned facility, refer to the FDI.
2. This section applies to the installation of fume hood exhaust systems (FHES). A fume hood is defined as a ventilated enclosed workspace intended to contain and exhaust fumes, vapors, or particulate, for the purpose of protecting occupants.
3. Design FHES to incorporate user needs, room configuration and limitations, existing ventilation design and limitations.
4. The FHES shall contain and remove fumes generated within the hood.
5. Failure to meet the performance requirements shall be cause for rejection of

the equipment and EH&S approval for general lab use may be withheld if the FHES does not meet design requirements.

6. FHES are required in many types of teaching, research and clinical laboratories. Discuss and identify requirements with the client and EH&S and Engineering Services. Anticipate and accommodate future research needs and design for maximum flexibility.
7. Design for adequate space for hood service and utility connections. Identify need and provide space in the current design for future hoods.
8. Constant volume and variable volume FHES are acceptable. Provide the rationale for the proposed system and the design criteria for the project early in design. EH&S and Engineering Services must participate in design decisions, including level of diversity. Diversity should be based on the unique characteristics and needs of the individual facility. Diversity less than 80% must be supported by an assessment of researcher practice and consider the effectiveness of both administrative and engineering controls.

   Good Practice
9. Fume hoods shall be located so that their containment performance is not adversely affected by swinging doors, ventilation diffusers, pedestrian traffic, other fume hoods or equipment, or any other sources of cross draft. Design so that the velocity of cross drafts at the face of the hood do not exceed 30% of the target face velocity. Makeup air shall be introduced at the 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 Z9.5-1992

   Air turbulence inhibits the capability of hoods to contain and exhaust contaminated air.
10. Fume hoods shall not be located adjacent to an exit unless a second means of exit is provided.

    NFPA 45 Chapter 6-9.2

    NFPA 45 Chapter 3-4.1(d)

    NFPA 99 Chapter 5-4.3.2

    A fire, explosion, or chemical release, any of which may start in a fume hood, can block an exit rendering it impassable.
11. Provide perchloric acid FHES with a dedicated fan and duct and wash-down system and locate on the building's top floor to minimize duct length and avoid horizontal duct runs; See Appendix A for wash down system requirements.
12. A radioisotope FEHS may be needed if high level labeling or specific radioisotopes such as Iodine or Astatine will be used. A radioisotope FHES requires a dedicated fan and duct. Consult with EH&S early in the project to determine if a radioisotope hood is necessary.
13. If the hood will be used for acid digestion or used with concentrated acids that

are highly corrosive to stainless steel, provide an acid digestion FHES. The hood, duct, and fan, must be made of fiberglass reinforced plastic or material with similar acid resistance. However, A/E must confirm design acceptability with both the University Fire Engineer and the local fire authority having jurisdiction prior to Design Development Phase.

14. Laboratory hoods shall not have local on/off or high/low control; exhaust fans shall run continuously. Exceptions may be granted for teaching labs.
15. Under hood storage units shall comply with Chapter 6 of this Design Guide.
16. Portable, non-ducted fume hoods are not permitted. Exceptions may be granted for single-process applications if approved by EH&S.
17. Provide a face velocity of 100 feet per minute (fpm) +/- 10% at a sash opening height of 18 inches.

    For renovations of existing facilities, a greater airflow may be necessary to comply with 10 air changes per hour requirement.

18. Noise levels measured at a distance of three foot in front of the sash at a target height of five feet from the floor, should not exceed 65 dBA, using a type 2 sound level meter per ANSI SI.4-1971 and an octave band filter for 31.5 to 4000 Hz.
19. Provide constant volume (CV) hoods with an automatic air bypass that limits the maximum face velocity to 300 lfm at a sash height of 6 inches. The hood air bypass shall not be dependent on mechanical or electrical linkage. Design the bypass to prevent hot gases, vapors, or debris generated by fire or explosion within the hood from being ejected through it directly at the operator. For example, if the design has the air bypass as horizontal slots on the front face, the slots shall be directed upward.
20. Variable air volume (VAV) hoods must maintain a minimum exhaust of 20 to 25% of design total cfm through a combination of a reduced bypass and horizontal deflector vane below the sash frame. The air bypass shall meet the same requirement as stated for a CV hood above. NOTE: For renovations of existing facilities, a greater airflow may be necessary to comply with 10 air changes per hour requirement.
21. Locate controls for hood utilities outside the hood, including receptacles for 110V power.
22. Hood lighting and other fixed electrical equipment within the hood shall be explosion proof, depending upon the intended purpose of the hood. Lights shall be changed from outside the hood.
23. If a cup sink is included, provide a dedicated trap for it and install with lip at least ¼ inch above the work surface to prevent accidental release to sewer.
24. Provide each fume hood with an audible and visible alarm that activate whenever the face velocity drops below 80 lfm. Provide the audible alarm with a timed silencing switch after which the alarm will sound again if the velocity is still less than 80 lfm. By pressing the silencing once, the alarm will silence for 5 minutes, upon pressing it a second time, the alarm will silence for 60 minutes.

    If the installation is for a renovation with a target sash height a full open, do not include the 60-minute

delay.

25. Equip water faucets in new installations and remodeled fume hoods with a vacuum breaker located outside the hood work chamber. It shall be accessible for maintenance and located to prevent a hazard from dripping or flooding.
26. Approved, automatic fire suppression systems shall be provided for hoods located in basements. The system shall be monitored for activation by the building fire alarm system.

SFD Administrative Rule for Basement Labs

D. Fume Hood Exhaust System Testing

1. Measure FHES face velocities, NOT just airflows, for each hood installed, and verify that velocities are within the target criteria. The average target face velocity of a hood intended for standard use shall be 100 fpm +/- 10%. The project shall include testing of face velocities using a thermoanemometer; the thermoanemometer is necessary for taking individual point readings. A minimum of two point readings (approximately 6 inches from the top and bottom of the sash opening) should be taken for every linear foot of sash opening. For example, at an 18-inch sash position for a 5-foot wide hood, 10 readings should be taken, five at 6 inches from the airfoil and five at 12 inches from the airfoil. Point readings shall be 100 fpm +/- 20%.
2. Calibrate velocity monitors and alarms, and verify that they are tracking appropriately.
3. Measure the terminal velocity of supply air nearest the fume hood. The supply air velocity shall not exceed 30% of the target face velocity at the top of the sash opening.
4. Once the contractor has verified that the face velocities, monitor and alarms, and terminal supply velocities at the hood face are within target criteria, EH&S will test the hood to confirm adequate performance, label it appropriately, and approve for use.
5. If this is not a University owned facility, see Appendix A for testing details of the FHES ducts. If it is a University owned facility, refer to the FDI.