University of Wisconsin - Madison
Fume Hood Program

Policies and Procedures for
Design, Installation, Operation, and
Maintenance of Campus Fume Hoods

August 2019

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I. Introduction

This document "R3" describes revised required practices for the design and operation of University of Wisconsin – Madison laboratory ventilation systems used for the control of exposure to air borne contaminants while conserving energy via best practices. The document is intended for use by campus faculty, students and staff, engineers, architects, industrial hygienists, safety engineers, chemical hygiene officers, environmental health and safety professionals, ventilation system designers, maintenance personnel, testing, controls and air balance specialists, energy engineers and the UW chemical safety committees.

II. Mission Statement & Policy

"Implement an efficient and effective program for the design, installation, operation, and maintenance of campus laboratory fume hoods and their associated systems to maintain the health and safety of occupants in and around UW-Madison campus buildings while conserving energy via best practices."

Required practices for the design and operation of University of Wisconsin laboratory ventilation systems used for the control of exposure to air borne contaminants are based on the following policies:

- The design and operation of campus laboratory ventilation systems shall maintain the health and safety of occupants while incorporating means and methods to conserve energy.
- UW-Madison laboratory ventilation and fume hood exhaust systems shall comply with the specifications set forth in this document and in the listed references in Appendix A. Fume hoods and associated ventilation systems shall meet minimum design and performance requirements in order to be placed in service and to remain in service.
- Performance of new and renovated laboratory fume hood systems shall be evaluated using Fume Hood Performance Testing Guidelines (Appendix C). Fume hood systems that do not meet testing criteria and specifications shall not be accepted for use.
- Performance of established laboratory fume hood systems shall be evaluated annually using the Procedures for Testing Fume Hood Systems. Fume hood systems that do not meet performance criteria and specifications shall be placed out of service.
- Fume Hood users shall be trained in the proper operation and use of a fume hood and adhere to the training outlined in the PI's laboratory chemical hygiene plan. The user shall establish work practices that minimize emissions and employee/student exposures.

III. Roles & Responsibilities

WI Department of Administration Division of State Facilities (DSF): Provides oversight, technical assistance, and development and delivery of projects requested via the Small Projects and All Agency Projects programs.

Facilities Planning & Management (FP&M) Physical Plant: Conducts annual testing and reporting of fume hood performance. Completes routine maintenance repairs of fume hoods and fume hood systems. Provides design and construction services for departmental requests of new fume hood installations and/or relocated fume hoods. Packages and submits projects to DSF for funding and delivery consideration.

FP&M Environment Health & Safety (EH&S): Addresses safety needs of faculty, staff, and students in campus buildings through compliance assessments, chemical use surveys and laboratory inspections. Develops and communicates protocols for laboratory and fume hood decontamination. Conducts risk assessment for lab design and accident investigations. Provides training assistance for fume hood use and chemical hygiene plans.

University Health Services Environmental Health Program (EHP): Addresses safety needs of students in campus buildings through certification programs for biological safety cabinets, laminar flow stations, and HEPA filters. Conducts ASHRAE 110 testing, IAQ air sampling and building entrainment studies.

Departmental Safety Committee/Coordinator: Coordinates the needs of individual laboratories within the context of all laboratories in a given department or building. Coordinates and prioritizes the needs of individual laboratories as related to the capabilities of building HVAC and lab service systems.

Facility (Building) Manager: Coordinates and communicates individual laboratory service and repair requirements to building occupants.

Principal Investigator (PI): Maintains user safety within the laboratory by monitoring that mechanical systems, lab services, and lab equipment are functioning properly; requests

repair work orders from physical plant (263-3333) to address malfunctioning systems and/or lab services. Maintains accurate and current information of the chemicals used in the lab and the lab chemical hygiene plan. Maintains inventories of radioactive and non-radioactive chemicals.

Researcher/Laboratory Manager/Student: Follows all safety and health procedures specified in the Chemical Hygiene Plan/Lab Safety Guide and by the PI or supervisor in the laboratory. Attends all required health and safety training sessions. Does not use fume hoods which have failed certification. Reports fume hoods which are not operating properly, accidents, unhealthy, and unsafe conditions to the PI or supervisor.

IV. Conflict/Issue Resolution

In the fume hood program, as with any program, misunderstandings and differences of opinions can arise; such as when dealing with fume hoods that do not meet the performance testing criteria. Most issues can normally be resolved by a meeting between the Principal Investigator, the facility manager and a representative of the Environment, Health and Safety Department. If a resolution is not reached then representatives of the following may be brought into the discussions:

- Campus Fume Hood Program Management Team / Fumehood Committee
- Departmental Safety Committee / Coordinator
- College Representative
- Campus Chemical Safety Committee
- Graduate School Research & Sponsored Programs

In all instances, the safety of personnel working within the facility must be paramount in determining the course of action.

V. Funding, Scope, and Delivery Guidelines

A. Supported and Non-Supported Buildings

UW-Madison buildings that are supported with funding by the UW-Madison physical plant maintenance operation are qualified to receive campus fume hood program funding for fume hood performance testing and repairs. Most campus buildings fall within this category.
Fume hood program testing and repairs in campus buildings that are not supported by the UWMadison physical plant maintenance operation shall be departmental funding responsibilities. Examples of non-supported buildings include leased facilities, VA Hospital, Clinical Science Center, UW Research Park facilities and Agricultural Research Stations.

B. Program Scope and Delivery

The campus fume hood program addresses the maintenance and safety requirements of fume hoods used for general laboratory chemical safety in supported campus facilities. Standard-flow fume hoods, high-performance fume hoods, and three-sided capture hoods that are utilized for this purpose are included in the scope of the campus fume hood program.
Fume hood annual performance testing is required per Wisconsin administrative code chapter Comm 32, section 32.24(6) with incorporated ANSI/AIHA Z9.5 laboratory ventilation standards. Testing is scheduled by building and prioritized by the date of last annual inspection.

Replace non-compliant fume hoods: Non-compliant fume hoods shall be scheduled for replacement and updated to campus standards. Non-compliant, standard-flow fume hoods may be replaced with high-performance hoods if hood sizes are not increased and/or if energy savings/payback may be realized. Replacement fume hoods shall be provided as available from physical plant, energy conservation projects, and appropriate DSF projects.

Minor repair problems: Repairs less than $5,000 shall be funded by the physical plant. Examples of minor repairs include maintenance and repair work orders for fan belts, lights, and monitors. Proper functionality shall be confirmed by the use of air flow monitors, air measurement analysis, or other performance testing means.

DSF Small Projects: Repair projects with budgets $5,000 – $150,000 shall be submitted to the Division of State Facilities (DSF) for funding consideration via the DSF Small Project program. Examples of small projects include fume hood exhaust fan replacements serving individual laboratories.

All Agency Projects: Project funds for fume hood system repairs with budgets greater than $150,000 are actively pursued through the DSF All Agency Projects program. Examples of All Agency projects include multiple exhaust fan replacements for fans supporting building fume hood exhaust.

C. Funding Exclusions

Fume hood annual performance testing is required per Wisconsin administrative code chapter Comm 32, section 32.24(6) with incorporated ANSI/AIHA Z9.5 laboratory ventilation standards. Funding for annual performance testing of fume hoods in non-supported buildings is a departmental funding responsibility.

Remodeling and Space Reassignment: Fume hood performance tests are conducted as a condition of acceptance when new hoods are installed or when existing hoods are included as part of a significant renovation. Performance testing is also required when a significant change is made to the operating characteristics of a hood. Costs associated with new installations and remodeling are departmental funding responsibilities.

ASHRAE 110 Testing of Fume Hoods: Tests are completed by the Environmental Health Program upon request and as required for new installations of high-performance hoods. Funding for ASHRAE 110 tests shall be provided by the requestor of the test.

Special Use/Point-of-use Ventilation Systems: Funding of the testing and repairs of laminar down flow hoods, slot hoods, HEPA filtered fume hoods, necropsy tables, wet benches, grossing stations, snorkel exhausts, and associated equipment shall be a departmental funding responsibility. Funding for testing and repairs of canopy hoods used to remove steam and heat shall be a departmental funding responsibility.

Special Use/Hazardous Ventilation Systems: Funding for fume hood testing and repairs of special use fume hoods and associated equipment shall be a departmental funding responsibility. The three main types of ventilation systems in this category are hazardous radiation, perchloric acid, and high volume/high hazard acid use (i.e., hydrofluoric acid) ventilation systems.

Vandalism or Misuse: Funding to repair damage to fume hoods caused by misuse or inappropriate use of a fume hood as well as any vandalism shall be a departmental or risk management funding responsibility. Reinstallation or repair of fume hood components removed or damaged by the user shall be a departmental responsibility. The nature of an experiment conducted within a fume hood shall not modify the integrity of proper fume hood function (e.g., too much equipment within the hood or protruding out of the hood).

Biological Safety Cabinets: Biological safety cabinets are not included in the campus fume hood program.

See Appendix A for additional information on hood types.

VI. Laboratory Design Standards

Laboratory exhaust ventilation systems designed, constructed, maintained, and used at the University of Wisconsin Madison campus shall comply with the specifications set forth in this document and the listed publications in Appendix A. The national standard ANSI/AHIA Z9.5-2003 for laboratory exhaust ventilation systems is used by the university.

A. Laboratory Configuration

1. Proper laboratory design is critical to ensure the health and safety of researchers and experiments. A detailed summary of the laboratory hazard classification, intended research use, and listing of chemicals to be used should be provided to the lab design team, including chemicals with corrosive, explosive, flammable, or radioactive properties. The potentially dangerous portion of an experiment is usually conducted in a fume hood. Many lab fires and explosions originate in fume hoods.
2. The following design guidelines should be followed to ensure a safe laboratory:
3. Fume hoods must be located so that persons exiting the lab do not have to pass in front of fume hood. Ideally, there should be two exits from rooms where new fume hoods are to be installed. If this is not feasible, the fume hood should be situated as far away as possible from the door.
4. Locating fume hoods directly opposite occupied work stations should be avoided. If this is not feasible, a minimum 48” clear in front of the hood must be maintained.
5. Fume hoods should not be located side by side unless a divider is located between the hoods to prevent contaminants pulled from one hood to another. Fume hoods should be located not less than 12” from an inside corner of a room.
6. Supply and or general laboratory exhaust air diffusers and grilles should be located and designed not to cause any air currents or cross drafts affecting the exhaust air flow to the fume hood.
7. Sufficient make-up air must be available within the laboratory to permit fume hoods to operate at their specified face velocities. The difference between the supply and exhaust volumes should not be more than 150 CFM up to two hoods and no more than 250 CFM for 3 or more hoods.
8. Windows in labs containing fume hoods must be fixed closed. Breezes from open lab windows can adversely affect the proper functioning of the hood. Turbulence caused by these wind currents can easily carry the contaminated air outside the sash into the operator’s breathing area.
9. Safety devices such as deluge showers, eye wash stations, and fire extinguishers should be conveniently located near personnel operating the fume hood.
10. New fume hoods shall not have an exhaust fan on/off control accessible in the laboratory. Fume hoods are an integral part of the entire laboratory's air balancing system which must be maintained.

Exception: Perchloric acid fume hood with wash down features is considered a specialty type use hood. This hood may be designed with a hood mounted on/off fan switch. If the on/off switch is utilized, a general exhaust grille will need to be installed in the lab to maintain negative pressure relationships.

B. Americans with Disabilities Act (ADA) Fume Hoods

There should be at least one ADA compliant fume hood in each type of classroom lab and in each building housing classroom labs. The intent of this requirement is to ensure that classes can be easily reassigned to alternative rooms, should the need arise to place a particular class in a lab with an accessible fume hood station. Fume hoods in research labs are not required to be ADA compliant unless there is a specific request.
An ADA compliant fume hood should have a lower sill that has been configured especially for persons in wheelchairs (between 28 and 34 inches above the floor) with at least 36" of the underside left open to allow for the necessary knee space. Controls must be within ADA compliant reach range. For a forward and/or side reach, this range is 15 to 48 inches above the floor. Light switch, all service nozzles and sash handle/edge must be within this reach range. The clear space in front of an accessible hood should be 48" from the face of the hood.

C. Fume Hood Exhaust Velocity

The following specified velocity ranges have been tested by University Health Services Environmental Health Program and verified as passing containment assuming acceptable cross draft and roof dispersal conditions and comply with Wisconsin Administrative Code 32.24 State Employee Safety.

High performance fume hoods: The ideal exhaust velocity design is 45-55 feet per minute (fpm) at full open sash and the acceptable face velocity range (open vertical sash) is 45 - 75 fpm maximum vertical sash. The ideal exhaust velocity range for the horizontal sash is 90 – 110 and acceptable range is 90 -150 fpm in the maximum horizontal sash opening (one/two panel). Status conditions for high performance combination sash fume hoods are defined with the sash in the maximum vertical position and horizontal sashes closed. However it is understood that field conditions may require the horizontal sash opening measurement because of hood design such as internal fume hood blower (DAT) and ceiling restrictions. Since each fume hood has only one independent TSI or TEL face velocity monitor, the low velocity set point the alarm shall activate at less than 85-fpm.

Three sets of acceptable field criteria are specified: Full Open Vertical sash, 18" Vertical sash and Full Open Horizontal sash. Each condition has a different open area and therefore three velocity ranges are specified, one for each sash position. Furthermore all high performance fume hoods use a large bypass airfoil three inches behind the operator safety bar.

Open Vertical Sash/Full Open
- Normal: Ideal 45 – 55 fpm
- Normal: Accept 45 – 75* fpm
- Restricted: < 45 fpm
- Shut Down: < 40 fpm
- High Velocity: > 75 fpm
- Low Vel Alarm: < 85 fpm

Open Horizontal Sash(s)/As Used
- Normal Ideal 90 – 110 fpm
- Normal: Accept 90 – 150* fpm
- Restricted: < 90 fpm
- Shut Down: < 85 fpm
- High Velocity >150 fpm
- Low Vel Alarm < 85 fpm

18" Open Vertical Only Sash /Non-Combo
- Normal: Ideal 90-110 FPM
- Normal: Accept 90-150* FPM
- Restricted: < 90 fpm
- Shut Down: < 85 fpm
- High Velocity: > 150 fpm
- Low Vel Alarm: < 85 fpm

If the fume hood face velocity requires adjustment, the system airflow shall be adjusted or the fume hood evaluated with recommendations which may require a containment test. In the event that the fume hood can not be adjusted within the normal range due to low airflow, the system airflow shall be increased. If the fume hood air velocity exceeds the acceptable range and the as found room exhaust can not be properly adjusted, the exhaust air duct work and room exhaust grill shall be changed to balance the fume hood air velocities to the ideal ranges stated.

*When employing high performance combination sash fume hoods it is recognized that different fume hood manufacturers may very from the stated acceptable ranges specified in this policy and that the fume hood may be the sole source of the laboratory exhaust. As a sole source the velocity maybe higher to maintain directional flow relationships from adjacent spaces, heat and cooling loads and allow for design air changes as specified by the engineer. The normal velocity range should still be followed and mechanical changes made to maintain the face velocity within the normal acceptance range (45 - 75) fpm Full Open. If field conditions prohibit operation in this range, the engineer can request a containment test for safety and/or economic reasons and should be prepared to adjust the room ventilation pending final results of the containment tests.

Vertical sash STANDARD fume hoods:

The ideal face velocity at the maximum open sash position shall be 90 - 110 fpm and the acceptable face velocity range (open vertical sash) is 90 - 150 fpm design vertical sash. The design sash position shall either be full open or 18 inches vertical sash.

Open Vertical Sash 18 inch sash position

- Normal: Ideal 90 – 110 fpm
- Normal: Accept 90 – 150 fpm
- Restricted: < 90 fpm
- Shut Down: < 85 fpm
- High Velocity: >150 fpm
- Low Vel Alarm: < 85 fpm

Vertical sash models shall not be certified below 18 inches on a standard vertical sash fume hood. If the 18" vertical sash position fume hood face velocity is below 95-fpm the system exhaust *should* be adjusted, below 85 – fpm the face velocity **shall** be adjusted upward. If the velocity is above 150-fpm the system exhaust shall be adjusted to revise the air exhaust ductwork and room exhaust grill under the direction of a campus engineer. The fume hood air shall then be air balanced to achieve the ideal velocity range of 90 – 110 fpm for full open vertical sash.

For face velocity measurement the hood vertical sash shall be either 18-inches or measured at the maximum vertical sash position and meet 95 - 150 fpm at 18 inch sash or 95 -150 fpm full open sash. As presented in the discussion section of ANSI /AHIA Z9.5 Laboratory Standard " Most laboratory experts agree that velocities above 150 fpm at the design sash opening are excessive at operating sash height and may cause turbulent flow creating more potential for leakage."

Horizontal sash standard fume hoods: *There are fume hoods which only have horizontal sash assemblies. The ideal face velocity at the maximum opening (one or two panels) shall be 90 – 110 fpm and the acceptable range shall be 90 – 150 fpm.*

Open Horizontal sash is defined as one or two panels
- Normal: Ideal 90 – 110 fpm
- Normal: Accept 90 – 150 fpm
- Restricted: < 90 fpm
- Shut Down: < 85 fpm
- High Velocity: >150 fpm
- Low Vel Alarm: < 85 fpm

The horizontal sash shall not be certified with less than one panel to achieve the face velocity. If the fume hood velocity is below 90-fpm the system lab exhaust should be adjusted, not the sash opening. If the face velocity is below 85-fpm the exhaust system air flow shall be adjusted. If the velocity is above 150-fpm the system exhaust shall be adjusted to revise the air exhaust ductwork and room exhaust grill under the direction of a campus engineer. The fume hood exhaust shall then be air balanced to achieve the required ideal face velocity range. 90 – 110 fpm.
For face velocity measurement, the hood horizontal sash panel shall be at the maximum open sash position (1 or 2 panel full open) or design sash position and meet 90 - 150 fpm. As presented in the discussion section of ANSI /AHIA Z9.5 Laboratory Standard(1) " Most laboratory experts agree that velocities above 150 fpm at the design sash opening are excessive at operating sash height and may cause turbulent flow creating more potential for leakage."

Combination sash standard fume hoods:

There maybe standard fume hoods which have horizontal and vertical sash assemblies. The airflow in these fume hoods are based on a design sash position. This was done to allow a large working zone plus energy conservation. The face velocity at the maximum horizontal opening (one or two panels) must be determined and maintained. Opening the vertical sash is only for laboratory set up and not measurement.

Therefore when a velocity traverse is made the vertical sash shall be down and secured. If lab equipment prevents center horizontal sash measurement use the open horizontal sashes created by the equipment and report. If the equipment in the hood causes more than two panels to be open the hood face velocity shall still comply with the table.

Combination sash with Open Horizontal sash one or two panels

• Normal: Ideal 90 – 110 fpm
• Normal: Accept 90 – 150 fpm
• Restricted: < 90 fpm
• Shut Down: < 85 fpm
• High Velocity: >150 fpm
• Low Vel Alarm: < 85 fpm

Changes or alterations to the laboratory and/or fume hood design sash opening shall be made under the direct supervision of the engineer of record or the assigned HVAC designer who has the final responsibility for approval and safety of the fume hood in consultation with the Environmental Health Program and Environmental Health and Safety Department.
When the fume hood face velocity exceeds the allowable range the engineer in charge can make mechanical changes to improve performance or request that the fume hood be quantitatively tested to verify or disprove containment. The evaluation team may test the fume hood at the design or operational sash position to verify that the fume hood operates safely in the as used condition or needs design alteration. Fume hoods proven to provide protection (4.0AU 0.1) outside the required velocity ranges can be tagged as approved for use at the posted face velocity and the ASHRAE 110 report maintained on file at Physical Plant until such a time that the fume hood is adjusted or modified and the face velocity is changed to comply with the table.
Face Velocity Alarm: TSI and TEL monitors: These monitors have optional low velocity and high velocity alarm set points. The low velocity set point shall be set to alarm at less than 85-fpm by consensus. Therefore at any time the user reports an alarm it will be associated with low face velocity. High face velocity shall be set > 15% of Closed Sash FPM to avoid nuisance reporting when the operator closes the sash and restricts the fume hood face opening with CV systems and short term alarm when the HVAC system is adjusting air flow in response to a change in the sash opening or occupancy change, also known as (system response time).

(1) ANSI/AIHA Z9.5 Laboratory Standard, Review Statement by the Z9.5 Committee

D. Fume Hood Alarms

All high performance fume hoods shall be equipped with an air flow measuring device and alarm. The device shall be located on the fume hood no higher than 72 inches from floor level. The device shall be field calibrated. The device should be calibrated to the operation sash position and have velocity read out, visual alarm and audio alarm. The device is calibrated by UW Physical Plant or the fume hood installer.

1. Combination sash (vertical/horizontal sash) fume hoods shall have an air flow alarm that gives a warning when the sash is vertically raised from the lowered position (1).
2. Required Sash Alarm: On Thermo Fisher Hamilton High Performance Fume Hoods, the fume hood is provided with a left hand post sash alarm system to alert the operator to close the vertical sash. This audio and visual system is in “Green” mode under normal operation, “Yellow” mode with an audio alarm “seat belt beep” when the vertical sash is raised above 18 inches. “Red” alarm when the vertical sash is left in the wide open position followed by a “loud beep” that can be heard everywhere in the lab. If the house ventilation to this fume hood fails or the hood auxiliary blower fails to run, the red light on the sash alarm and the “loud beep” will actuate until the problem is corrected, airflow restored and the vertical sash is lowered. .
3. Standard Laboratory Fume Hoods operated at 100-fpm or less at the 18-inch vertical sash stop position shall be provided with a calibrated air flow measuring device and alarm when the sash is raised above the sash stop position, 18 inches, to alert the fume hood operator to close the sash or if a major change in air velocity has occurred. This alarm should be programmed to alarm with audio and visual alarms. The flow measuring device shall be checked for calibration annually and if found defective, repaired or replaced with a calibrated device.

E. Ductwork

Ductwork construction, reinforcement, and duct support specifications shall follow the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) standards and DSF Master Specifications standards.

1. Fume hood duct construction is specified based upon a review of the chemical usage list provided by the researcher. Typical duct applications are as follows:
• Poly vinyl coated steel (PVS) is used for most standard laboratory applications. It has a good resistance to weather, mineral acids, alkalines, and many chemicals. It is not dissolved or softened by alcohols and petroleum solvents.
• Polymerized Vinyl Chloride (PVC) duct work is typically used in a more aggressive acid environment. Hydrofluoric acid exhaust would be an application for PVC. This material becomes brittle over time and could crack.
• Chlorinated Polyvinyl Chloride (CPVC) has comparable corrosion resistance to PVC pipe, yet it is suitable for handling corrosive material at temperatures 40 to 60 degrees higher than PVC. This is not recommended for use with compressed air.
• Stainless Steel 316-L is very corrosion resistant to severe duty with many chemicals.
2. All fume hood duct work must be sealed air tight at joints and seams.
3. Fire control type dampers will not be utilized in any fume hood exhaust ductwork.
4. Ductwork velocities in branches and mains should be maintained between 1500-2000 linear feet per minute- (fpm) to minimize noise, static pressure loss, and blower power consumption within a duct system.
5. All horizontal ducts should be sloped down towards the fume hood (Guideline: 1/8" to the foot). Liquid pools, which result from condensation, can create a hazardous condition if allowed to collect.
6. Gang ducting of fume hoods is not recommended unless required by special conditions. These

must be properly designed with final approval from EH&S and Physical Plant. Gang ducting of fume hoods that may be used for radiological materials with half lives greater than 30 days is not allowed under any circumstances.
7. New duct work installations should be tested at a negative pressure, 1 ½ times its operating pressure. Tests should show zero leakage but no more than 2 percent of design airflow capacity.

F. Exhaust Fan and Stack

1. Exhaust fans should be located exterior to the building on the roof to provide negative pressure in all fume hood ductwork located inside the building.
2. Fume hood exhaust should be located as far from fresh air intakes as possible (but at least 30 feet) to prevent re-entrainment of exhaust fumes back into the building.
3. Fume hood exhaust stack termination should be a minimum of 10 feet above the roof or 2 feet above a parapet wall, which ever is greater. Discharge must be directed vertically upward.
New exhaust fans should be oriented in an up-blast orientation.
4. Discharge velocities at the stack termination shall be between 3000 to 4000 FPM. A sufficient discharge velocity is necessary to adequately disperse contaminants and allow service personnel access. At the velocities listed exhaust plumes should go 15 to 30 ft. above the exit point before any noticeable change.
5. Sound levels of an exterior exhaust system shall be no greater than 75-dbA 5 feet from the fan in any direction. Fume hood sound levels should be restricted to 60-dbA at 12 inches in front of the open sash.

G. Plumbing

1. All Plumbing utilities must have a shut-off valve adjacent to the hood.
2. Hot or cold water supplies must be connected to potable water system. For hot water use presoftened water. Hot and cold city water supplies shall be protected by atmospheric vacuum breakers. Vacuum breakers shall be accessible for service.
3. Verify with the hood user what specific laboratory gases and services will be needed. If special tanks for gases are required, provide wall chains to secure the tanks.

H. Electrical

1. Electrical outlets must be located outside the hood. Minimum electrical service to the hood should be a 20-amp, 120-volt circuit. Ground fault circuit interrupter (GFCI) protection is recommended. Reference 2008 NEC article 210.8 (B) (5) exception #1.
2. Lighting fixtures all should be of the fluorescent type rated for daylight color and produce 80 foot candle at the work surface. Light fixtures should be sealed and vapor tight, UL-listed and protected by a transparent impact resistant shield. Fixtures shall be accessible for bulb replacement without having to take the fume hood apart.
3. The potential for flammable, combustible and corrosive atmospheres requires explosion-proof electrical equipment.

I. Sashes

1. Sashes may be horizontal, vertical, or a combination, and should have the capability to completely close off the hood face.
2. Sashes should be made of safety glass:
• Laminated safety glass for standard use when internal temperature is anticipated to be less then 160 ºF.
• Tempered safety glass when high internal temperatures are anticipated that will result in sash surface temperatures greater than 160 ºF.

• Where hydrofluoric acid is used, sashes will be made of plastic or lexan with a flammability rating of 25 or less when tested in accordance with ASTM E162-76.
3. Horizontally sliding sash panels may not be less than twelve inches, nor more than fifteen inches in width. Such sashes may offer extra protection to lab workers as they can be positioned to act as a blast shield for small explosions and projectiles.

J. Requirements for Special Use/Hazardous Ventilation Systems

Radioisotope Hood
This fume hood is made with a coved stainless steel liner and coved integral stainless steel countertop that is reinforced to handle the weight of lead bricks. If research is planned with volatile radioisotopes, contact the University of Wisconsin – Madison, Radiation Safety Officer at 265-5000.

Acid Digestion Hood
These units are typically constructed of polypropylene in order to resist the corrosive effects of acids at high concentrations. If hydrofluoric acid is being used in the hood, the hood's glass sash should be constructed of polycarbonate which resists etching. Hood ductwork should be lined with polypropylene or coated with PTFE (Teflon).

Perchloric Acid Hood
Concentrated or hot perchloric acid is highly oxidizing and extremely corrosive. It addition the fumes can settle and form shock-sensitive crystals. For this reason specially designed fume hoods should be designated for work with the acid. These fume hoods are designed with the following characteristics:
1. Fume hoods designated for use with perchloric or other acids shall be identified by a label indicating suitability for use with perchloric or acid procedures.
2. All exposed hood and duct construction materials shall be suitable for use with perchloric or other acid - inorganic, non-reactive, acid resistant and relatively impervious.
3. The work surface in the hood shall be water tight and dished or furnished with a raised bar to contain spills and wash-down water. The Perchloric acid fume hood and exhaust ducting design shall be provided with a water spray (wash-down) system. The baffle must be removable to allow for periodic cleaning and inspection.
4. Each perchloric acid fume hood must have an individually designated duct and exhaust system. The duct system should be straight, vertical and as short as possible.
5. Use only plastic or plastic-coated metallic fan.
6. The perchloric acid fan motor must be located outside of the air stream.
7. The hood liner and work surfaces are usually stainless steal, sealed with welding at all seams.

VII. Fume Hood Procurement

A fume hood that is approved under UW-Madison procurement contract #07-5763 shall be used. Refer to website http://www.bussvc.wisc.edu/purch/contract/wp5763.html for details.
MANUFACTURER VENDOR
LAB CRAFTERS AIR SENTRY LAB CRAFTERS
FISHER HAMILTON PIONEER WYNN O JONES & ASSOCIATES

A. Variable Air Volume Hoods

Variable-air volume fume hoods and constant volume high performance fume hoods shall be installed unless accepted design practice dictates otherwise. A VAV hood is one that is fitted with a face velocity control which varies the amount of air exhausted from the fume hood in response to the sash opening to maintain a constant face velocity. These hoods produce an acceptable face velocity over a relatively large sash opening and also provide significant energy savings by reducing the flow rate from the hood when it is closed. High performance Fume hoods require less exhaust ventilation system maintenance since the hood operates at constant volume. These hoods conserve energy by using less air. They also can be made to operate as VAV for additional energy savings.

B. Constant Flow Hoods

Standard constant flow hoods are not encouraged during new construction or renovations. Use the high performance fume hood or standard fume hood with VAV hoods are preferred over standard constant flow hoods because VAV and high performance hoods provide greater flexibility in usage.

C. Re-circulating Hoods

Re-circulating or ductless fume hoods are not permitted for the removal of chemical, biological or radiological contaminants. UW does not service such hoods and the EH&S prohibits the use on campus.

D. Special Use Fume Hoods

ANSI/AIHA Z9.5-1992 and ANSI/AIHA Z9.2-2001 provide standards for non-traditional laboratory fume hoods. These hoods include: perchloric acid fume hoods, floor-mounted fume hoods, and glove boxes. ACGIH's “Industrial Ventilation – A Manual of Recommended Practices” provides information on perchloric acid fume hoods, biological safety cabinets, and glove boxes. All class II biological safety cabinets must meet the National Sanitation Foundation Standard Number 49, for Class II Biohazard Cabinetry, for design, manufacturing and testing.

E. Evaluation Requirement for Procurement Consideration

General guidelines on types of hoods and their application are presented in ACGIH’s “Industrial Ventilation – A Manual of Recommended Practices” (most current edition). Laboratory fume hoods and associated exhaust ducts should be constructed of noncombustible, nonporous material that will resist corrosion. They should be equipped with vertical or horizontal sashes, air foils built into the fume hood at the bottom and the sides of the sash opening, and baffles to attain a uniform face velocity under different conditions of hood use. Combination horizontal and vertical sashes shall be provided unless special conditions dictate otherwise. Additionally, recognized design and construction features are listed in the ANSI/AIHA Z9.5-2003 standard titled, “Laboratory Ventilation,” and ANSI/AIHA Z9.2-2001 standard, “Fundamentals Governing the Design and Operation of Local Exhaust Systems.”

Fume hoods should be tested before a hood leaves the manufacturer using the ANSI/ASHRAE 110 110-2007 standard, “Method of Testing performance of Laboratory Fume Hoods.” All new hoods shall meet the ANSI/ASHRAE 110 requirements for Class 1 hoods including a tracer gas performance of AM (as manufactured) 0.05 (parts per million) or better at a tracer gas release rate of 4.0 Liters per minute (lpm).

See Appendix F for additional information.

VIII. Procedures for the Proper Use of a Fume Hood

Fume Hood users shall be trained in the proper operation and use of a fume hood and the training outlined in the laboratory chemical hygiene plan. New user training and refresher training should be provided. EH&S is available to assist upon request. The user shall establish work practices that reduce emissions and employee or student exposures. For high volume/high hazard acid use fume hoods the fume hood user shall review these rules more frequently and may need additional personal protection equipment.

The following basic rules shall be constantly emphasized by the teaching assistant, investigator or responsible person in charge of the laboratory.

1. The user shall not modify the interior or exterior or components of the fume hood without approval of the designated chemical hygiene officer, responsible person or other appropriate authority in the organization.
2. The user shall not enter the 3 inch zone in front of the open face plane of the fume hood when contamination is present. If the operator must enter this area the use of a respirator shall be evaluated by risk analysis of the planned experimental emissions.

Alternatively the operator can work behind the sash to gain closer access to the hood interior. The operator should never enter the fume hood interior except during set up without the presence of hazards and after the hood has been decontaminated.
3. When operating the fume hood, the sash should be positioned to maximize the protection of the user.
4. Equipment and materials shall not block the hood air slots or interfere with the smooth flow of air into the fume hood. This includes the airfoil.
5. Tubes and appliance cords shall be routed through fume hood Iris ports if provided. Otherwise route tubes and cords under the airfoil to allow sash closure.
6. All work shall be done 6-inches behind the plane of the sash opening.
7. Large objects shall be elevated at least 1.5 inches off the fume hood work zone.
8. Flammable liquids should not be stored permanently in the fume hood or cabinet under the fume hood.
9. The fume hood sashes shall be closed as much as possible during active experiments and closed completely when the operator leaves the fume hood.
10. The fume hood sash shall not be opened beyond the design sash position when the hood has contamination present.
11. Traffic shall be restricted in front of the fume hood.
12. Rapid movements by the operator inside the work zone shall be restricted when contamination is present.
13. The fume hood shall not be operated unless verified that the hood is in working status.
14. Sash panels shall be opened and closed slowly, no rapid movement which could create a spill or damage the sash assembly.
15. House fans shall not be used in a laboratory. If the temperature of the lab is unacceptable contact the building manager to correct the problem. Do not use personal fans or open lab windows.
16. Consult with the laboratory manager and principle investigator regarding the need for a respirator if you must enter the work zone in the fume hood when hazardous emission(s) are present. By all means try and plan experimentation so no one has to enter the fume hood and can work behind the sash when hazards are present.
17. If the fume hood is provided with water service(s), the water service lines have back flow prevention valves. The valve is on the outside front of the fume hood. The device can leak water periodically. If this occurs contact the UW Plumbing shop to have the valve repaired.
18. Combination sash fumes hood operators, use the vertical sash for experimental set up involving large objects or need for full range of motion and the horizontal sashes for active experimentation and leave the vertical sash down.
19. **Special Precaution**: Hydrofluoric acid (HF) is highly corrosive and readily penetrates the skin, causing destruction of bone and tissue. Unlike other acids, pain from an exposure is often delayed, thus exposures can initially go unnoticed. Since inhalation of HF vapor can seriously damage the lungs, work with HF should be performed in a properly functioning fume hood. It is also important to note that HF, especially at elevated temperatures where the vapor concentration is higher, is also well known to etch glass. This can cause damage to glass sashes which are expensive to replace. Glass sashes that appear cloudy should be examined.
20. **Special Precaution:** Working with perchloric acid poses a unique risk which may require use of a specially designed fume hood. Perchloric acid is a strong mineral acid and at elevated temperatures is highly oxidizing. Most importantly, with respect to fume hoods, use of perchloric acid can lead to a buildup of perchlorate residues on surfaces and in duct work. These residues are highly reactive and can explode or ignite under certain conditions. For this reason special fume hood systems have been designed for use with perchloric acid. These fume hoods have a water wash down system which removes any residues from hood, ductwork and fan.

A specially designated perchloric acid fume hood must be used if any of the following is applicable:

- Concentrated perchloric acid (60% or greater) is used

• Perchloric acid (at any concentration) is used at elevated temperatures
• Perchloric acid is used under conditions where it may become concentrated (such as with strong dehydrating agents)

The wash down system should be used after each operation. Do not handle sulfuric acid, acetic acid, organic solvents, or combustible materials in a perchloric acid hood. It is permissible to use nitric acid in a perchloric acid fume hood.

Note: Concentrations greater than 72.5% are anhydrous solutions and are unstable and can explode when coming in contact with organic materials. Anyone requiring the use of anhydrous perchloric acid must contact EH&S prior to use.

IX. Fume Hood Performance Testing

Fume hood performance tests are conducted when new hoods are installed or when existing hoods are included as part of a significant renovation as a condition of acceptance. In addition tests are conducted annually or whenever a significant change is made to the operating characteristics of the hood.

Annual testing is required per Wisconsin administrative code chapter Comm 32, section 32.24(6) with incorporated ANSI/AIHA Z9.5 laboratory ventilation standards. Testing is scheduled by building and prioritized by the date of last annual inspection.

Refer to Appendix C for additional information on testing protocols.

X. Maintenance & Repair of Fume Hoods

A. Work Requests

Work Task (in ascending order of priority) Resource Work Code

Restricted - low airflow Sheetmetal S-FH03
Shutdown - low airflow Sheetmetal S-FH04
Hood usage issue EH&S review
Fire damage EH&S review
Analyze hood for replacement Sheetmetal review
Cross draft problem Sheetmetal S-FH14
Down flow problem Sheetmetal S-FH15
Room pressure Sheetmetal S-FH07
Repair superstructure - baffle, sash, liner Sheetmetal S-FH13
Repair sash Sheetmetal S-FH08
Repair glass Paint I-G15
Repair lights and electrical outlets Electric E-44
Repair base cabinet and work surface Carpenter C-22
Repair plumbing fixtures Plumbing P-F27
Repair backflow preventer Plumbing P-E18
Calibrate air-flow monitor Sheetmetal S-FH-11
Repair or replace air-flow monitor Sheetmetal S-FH05
Repair sash monitor Sheetmetal S-FH05
Pressurized exhaust duct Engineering review
High air flow Sheetmetal S-FH16

B. Maintenance Staff Requirements

The following procedures are to be followed by anyone who services fume hoods at UW.

1. Communicate to laboratory personnel the need to service the fume hood and obtain permission to shut down the system. If lab personnel are not available, contact the facility manager to obtain permission to shut down the hood. Do not turn off fan without permission from an authorized person. Scheduled shutdowns shall be communicated to the building occupants by the building facility manager. Additional approval from EH&S may be required for special use/hazardous ventilation systems (SUVS)
2. Locate the blower or motor on the roof to be serviced and the room in which it is housed.
3. Fill out an “OUT OF SERVICE” notice and fix it to the hood sash.
4. Shut down the fan and perform appropriate work.
5. After service is completed, restart the fan and remove the notice from the fume hood(s).

C. Laboratory Staff Requirements

During routine servicing, repair or dismantling of fume hoods, the potential exists for exposure to hazardous substances that have been used or stored in the hood. Hazardous substances should be removed depending on the nature of the material in the hood and the work being performed on the hood. Contact EH&S for advice is unsure whether materials should be moved out of the fume hood. To protect laboratory personnel and maintenance staff, do not perform any hazardous experiments while the fume hoods are being serviced.

D. Contractors working with Fume Hoods, Fans, and Ductwork

In addition to requirements outlined in the above Section X.B. all contractors and subcontractors not associated with DSF projects shall notify CARS (263-3333) prior to entering and working in campus buildings.

XI. EH&S Requirements/Recommendations for Maintenance & Repair of Fume Hoods and Associated Ductwork

Fume hoods can be broken down into two general types; general use fume hoods and special use/hazardous ventilation systems (SUVS). The SUVS require additional practices and procedures beyond those described for the general use fume hoods. When Special Use Ventilation Systems (SUVS) are scheduled for repair or maintenance, the system must be tested for the presence of radioactive materials or hazardous chemicals. EH&S will determine the need for testing and decontamination of the system, in conjunction with the faculty member. If decontamination is necessary, the system must be decontaminated before maintenance. The following outlines the general EH&S requirements concerning fume hoods. Contact EH&S should any questions arise concerning safety issues.

A. General Use Fume Hood Systems

Fume hoods are, by their very nature, designed for use with hazardous materials. Hazardous substances should be removed or enclosed by laboratory staff prior to work involving work on and/or shut down of the ventilating system (including ductwork). Interior surfaced of fume hood and ductwork servicing these fume hoods may be contaminated with hazardous materials. While it is unlikely that enough hazardous materials can accumulate on these surfaces workers, these standard precautions are sufficient to protect against chemical residues. Workers should take routine precautions to protect themselves during all construction, maintenance and demolition. Routine precautions include:

- Work clothes and gloves to prevent contact with hazards. These should be laundered separately from family laundry.
- Good personal hygiene to prevent accidental ingestion. This means washing hands and face before eating or using tobacco and before going home.
- Using a dust mask when dusty conditions are expected. This is especially appropriate when working on the ductwork or during demolition.
- Eye protection, hard hats and other general protective gear.

B. Asbestos

Asbestos-cement (Transite) is a tough, rigid, chemical and heat resistant material that was used extensively for fume hood lining, shelving and ductwork. The asbestos content of the material presents no hazard as long as the material is intact. However, cutting, breaking, drilling, filing, etc. will release asbestos fibers unless precautions are taken. Any activity that releases asbestos fibers requires special precautions. Certified workers must perform the work according to federal and state regulations.

C. Biological Hazards

Fume hood systems are not designed for use of biological pathogens since they lack HEPAfiltration.
No biological hazards are expected

D. Radiation Ventilation Systems

Radiation ventilation systems shall have a swipe test to check for the presence of radioactivity prior to performing maintenance work. Contact the UW Radiation Safety Officer before working on any radiation ventilation systems. Notify the faculty member who uses the system prior to commencing any maintenance. In addition, the following requirements apply to radioisotope fume hoods:

1. Facilities Service personnel shall contact the person responsible for the lab to schedule service, and shall NOT enter a laboratory or area marked "RESTRICTED" for radiation safety unless accompanied by the authorized user or Radiological Safety Office personnel. Written Radiological Safety Officer (RSO) approval may be posted on the hood by the user prior to servicing.
2. All radiological hoods shall vent separately to the outside of the building.
3. The RSO shall provide a list of fume hoods used for radiological materials.
4. Any person working or assisting with fume hood repairs in radioactive materials laboratories must be under supervision of the authorized user of radioactive materials. The only exception is work which has specific written prior approval of the RSO.
5. Maintenance personnel are to receive basic radiation safety instruction from the RSO prior to work in active laboratories.
6. Radioactive materials shall be secured against unauthorized removal, and all surfaces decontaminated and surveyed to assure that no contamination remains when unattended. This is to assure that no radiation hazard is present during routine, nonscheduled maintenance activities.
7. If radioactive materials are unattended for any reason without direct supervision by the user or trained assistants, the room shall be locked to prevent unauthorized entry and posted "RESTRICTED" for radiation safety purposes.
8. The authorized user or his assistants shall promptly notify the RSO of any spill, accident, or any operation which may have contaminated the hood or released any contamination through the hood to ductwork or air in an uncontrolled area.
9. The user shall provide documentation of radiation and contamination surveys of the hood for all scheduled maintenance and repair work, including face velocity calibration.

E. Perchloric/High Volume/Hazard Acid Use Ventilation Systems

Working with perchloric acid poses a unique risk which may require use of a specially designed fume hood. Perchloric acid is a strong mineral acid and at elevated temperatures is highly oxidizing. Most importantly, with respect to fume hoods, use of perchloric acid can lead to a buildup of perchlorate residues on surfaces and in duct work. These residues are highly reactive and can explode or ignite under certain conditions. For this reason special fume hood systems have been designed for use with perchloric acid. These fume hoods have a water wash down system which removes any residues from hood, ductwork and fan.
A specially designated perchloric acid fume hood must be used if any of the following is applicable:

- Concentrated perchloric acid (60% or greater) is used
- Perchloric acid (at any concentration) is used at elevated temperatures
- Perchloric acid is used under conditions where it may become concentrated (such as with strong dehydrating agents)

The wash down system should be used after each operation. Do not handle sulfuric acid, acetic acid, organic solvents, or combustible materials in a perchloric acid hood. It is permissible to use nitric acid in a perchloric acid fume hood.
Note: Concentrations greater than 72.5% are anhydrous solutions and are unstable and can

explode when coming in contact with organic materials. Anyone requiring the use of anhydrous perchloric acid must contact EH&S prior to use.

Perchloric acid hood systems may require a special test to determine the presence of explosive perchlorate crystals prior to performing maintenance work. Contact the Chemical Hygiene Officer (CHO) before working on any perchlorate or acid hood systems. Notify the faculty member who uses the system prior to commencing any maintenance. In addition, the following requirements apply to perchloric acid fume hoods:

1. Laboratory fume hoods designated for use with perchloric or other acids shall be identified by a label indicating suitability for use with perchloric or acid procedures.
2. All exposed hood and duct construction materials shall be suitable for use with perchloric or other acid - inorganic, non-reactive, acid resistant and relatively impervious.
3. The work surface in the hood shall be water tight and dished or furnished with a raised bar to contain spills and wash-down water.
4. The perchloric acid fume hood and exhaust ducting design shall be provided with a water spray (wash-down) system. The baffle must be removable to allow for periodic cleaning and inspection.
5. Each perchloric acid fume hood must have an individually designated duct and exhaust system. The duct system should be straight, vertical and as short as possible.
6. Use only plastic or plastic-coated metallic fan.
7. Do not use lubricants, caulking materials, gaskets or other materials in the fan which are not compatible with perchloric or other acids. Use fluorocarbon type grease.
8. The perchloric acid fan motor must be located outside of the air stream.

Appendices

Appendix A – Definitions

biological safety cabinet (BSC): Cabinets designed to provide for the control of airborne particulates and aerosols within a confined space through the use of directional airflow and high efficiency particulate arresting (HEPA) filters.

The operational integrity of a new biological safety cabinets (BSC) must be validated by certification before it is put into service or after a cabinet has been repaired or relocated. It is be the responsibility of the faculty member to have the BSC tested and certified annually by EHP. The faculty member is also responsible for decontamination of the BSC. Certification will be performed by UW Environmental Health Program which has accredited certifiers using the National Sanitation Foundation (NSF) Standard Number 49 for Class II Biological Safety Cabinets. All biological safety cabinets shall be purchased off the UW Purchasing Contract for biological safety cabinets. BSC must meet NSF-49 and comply with campus purchase specifications and procurement contract.

building envelope: the three-dimensional space surrounding a building containing the building's makeup air.

distillation (or acid) fume hood: a fume hood which is larger than a bench model and has double vertical sashes and lots of fume hood sinks and water supplies; Also sold with combination sashes examples are located at Chemistry-Shain Tower. A distillation fume hood is one in which liquids are heated to boiling and the condensate collected in a water or liquid cooled condenser. Water is the typical cooling liquid. The atmospheric backflow valve on the water lines prevents condenser water from entering the potable water system. Condenser water is normally discharged into the fume hood water drains and eventually to the sanitary sewer. Drains normally are in the fume hood work zone and must be checked for blockage. Distillation fume hoods come in all sizes and are fitted with lattice racks which are not in this picture and variacs in order to heat up liquids to a desired temperature and condense the vapors with the water cooled condensers. Liners are generally the standard resin cement board; Special liners only on request by the user such as stainless steel for a particular acid such a perchloric acid. The thing to remember is a distillation can be done in a standard fume hood and if the user is going to be conducting large numbers of distillations he buys a fume hood set up for running 5 or more distillations at the same time. Then he buys a distillation fume hood like in the picture which allows for large condenser racks and big experiments. So why do distillation in a fume hood? Because some distillation

condensers vent to atmosphere and acid vapor could get into the lab air harming people and experiments. Also if there is an accident better in the fume hood so you don't harm people and building components.
Distillation Fume Hood or Acid Fume Hood
downwash: pollutants discharged from an exhaust stack that travel towards the ground due to insufficient discharge velocities, poor wind dispersion, and physical obstructions.
exhaust air: the air that is removed from an enclosed space and discharged into atmosphere (ANSI/AIHA Z9.5 - 1992).
face velocity: average velocity of air moving perpendicular to the hood face, usually expressed in feet per minute (fpm) or meter per second (m/s) (ANSI/ASHRAE 110 110 - 1995).
floor-mounted hood: a fume hood designed to be floor mounted with sash and/or doors for closing the open face (ANSI/AIHA Z9.5 - 1992).
fume hood type: there are many types of hoods, each with its own design and function.
1. Conventional Fume Hood: Single vertical sash-Figure 1
2. Horizontal Sash Fume Hood: Multiple horizontal sashes-Figure 2
3. Combination Sash Fume Hood: Vertical & Horizontal sashes-Figure 3
4. Fixed Side Panel Fume Hood: Vertical sash in the middle
5. Polypropylene FH No HEPA Filter – Figure 4
6. Polypropylene FH with HEPA Filter & Blower -Figure 5
7. Special Operations Hoods
a. Canopies
b. Biological safety cabinets
c. Laminar benches
d. Snorkels
e. Downdraft tables
f. Slot exhausts
g. Isolator
h. Glove box
i. Re-circulating

Figure 1
Single vertical sash
Conventional Fume Hood-Vertical Sash
Constant Air Volume, Open bypass
Variable Air Volume, Restricted bypass
Bench Top or Floor Mount

Figure 3
Combination sash Fume Hood Vertical & Horizontal
Sashes
High Performance Combination Sash; Air Foil Bypass
Constant Air Volume, Conventional FH Open Bypass
Variable Air Volume, Conventional FH Restricted Bypass
Bench or Floor Mount

Figure 4
Fixed Side Panel Fume Hood
Vertical Sash
Constant Air Volume Airfoil bypass
Variable Air Volume Airfoil bypass
Bench Mount

Figure 2
Multiple horizontal sashes, No vertical sash
Conventional Fume Hood-Horizontal Sash
Constant Air Volume, Open bypass
Variable Air Volume, Restricted bypass
Bench Mount or Floor Mount

Figure 5
Polypropylene HEPA Filtered Fume Hood with internal
Internal Blower & HEPA filtered work zone.
Constant Air Volume.
Special Applications from General Use FH, Ultra-clean
Containment, Ultra-clean and Containment.
Integral under cabinet.

Figure 6
Polypropylene Fume Hood No HEPA Filter
Restricted Vertical sash
Variable Air Volume MFG Model Nu 162
Constant Air Volume MFG Model Nu 164
Used with boiling acids and related support processes
Integral under cabinet

Figure 7
Student Fume Hoods
Fixed sash opening or no sash
Constant Volume
Small internal volume & size
Low Hazard experiments

glove box: a boxlike structure provided with tight-closing doors or air locks, armholes with impervious gloves sealed to the box at the armholes, and exhaust ventilation to keep the interior of the box at negative pressure relative to the surroundings (ANSI/AIHA Z9.5 - 1992).
high performance fume hood: A high performance fume hood is a fume hood designed to operate at a reduction in the required exhaust volume from the traditional fume hood of 100 feet per minute (fpm) with the sash in the full open vertical position and has a validated containment level of 8.0 AM 0.05 (8 liters per minute gas challenge as manufactured with an instantaneous leak rate of less than or equal to 0.05 parts per million) with a sash opening of 24-inches or higher (vertical sash) opening at 45-55 fpm face velocity.
hood face: the plane of minimum area at the front portion of a laboratory fume hood through which air enters when the sash(es) is (are) fully opened, usually in the same plane as the sash(es) when sash(es) is (are) present (ANSI/ASHRAE 110 - 1995).
internal condensation: fumes and vapors that condense into liquids inside of the exhaust stack.
laboratory fume hood: a boxlike structure enclosing a source of potential air contamination, with one open or partially open side, into which air is moved for the purpose of containing and exhausting air contaminants, generally used for bench-scale laboratory operation but not necessarily involving the use of a bench or a table (ANSI/ASHRAE 110 - 1995).
lpm: liters per minute (ANSI/ASHRAE 110 - 1995).
makeup air: outside air drawn into a ventilation system to replace exhaust air (ANSI/AIHA Z9.5 - 1992). Makeup air MUST always be provided when any exhaust system is designed and installed.
perchloric acid hood: a fume hood constructed with water wash so it is safe for use with perchloric acid or other reagents that might form flammable or explosive compounds with organic

materials of construction (ANSI/AIHA Z9.5 - 1992).
recirculation: air withdrawn from a space, passed through a ventilation system, and delivered again to an occupied space (ANSI/AIHA Z9.5 - 1992).
reentrainment: see reentry.
reentry: The flow of contaminated air that has been exhausted from a space back into the space through air intakes or openings in the walls of the space (ANSI/AIHA Z9.5 - 1992).
replacement air: see makeup air
return air: air being returned from a space to the ventilation fan that supplies air to a space (ANSI/AIHA Z9.5 - 1992).
special use/hazardous ventilation system: A Special Use Ventilation System (SUVS) is a ventilation system in which highly hazardous materials are employed. The mechanical equipment contained in the SUVS includes the motor and all working parts, the motor cage, air inlets (including fume hoods and canopy ducts), air outlets (including stack) and all associated ductwork. There are four main types of SUVS:

- Radiation Ventilation Systems
- Perchloric Acid Ventilation Systems
- Infectious Agent Ventilation Systems
- High Acid Use Ventilation Systems

special use/point-of-use ventilation system: an exhaust hood, not otherwise classified, for a special purpose such as- but not limited to - capturing gases from equipment such as atomic absorption, gas chromatographs, liquid pouring or mixing stations, and heat sources (ANSI/AIHA Z9.5 - 1992).
variable air volume fume hood: a fume hood designed so the exhaust volume is varied in proportion to the opening of the hood face by changing the speed of the exhaust blower or by operating a damper in the exhaust hood (ANSI/AIHA Z9.5 - 1992).
velocity: speed and direction of motion (ANSI/AIHA Z9.5 - 1992).
wet bench: a specialized fume hood typically found in ECB clean rooms for example which provides an enclosure where liquids are processed safely. The service and process are the same. The wet bench provides a place work can safely be done and the wet bench confines the wet processes. Another example is the anatomy down draft wet bench. The down draft keeps vapors and liquids from escaping into the operator’s breathing zone such as the down draft wet bench at the UW Primate Center.
Wet Benches

Appendix B – References

ACGIH. “Industrial Ventilation - A Manual of Recommended Practice.” American Conference of Governmental Industrial Hygienists, Ed. 26, 2008 (or the most recent edition).
Available from:
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1330 Kemper Meadow Drive
Cincinnati, OH 45240
ANSI/ASHRAE 110. “Method of Testing Performance of Laboratory Fume Hoods.” American Society of Heating, Refrigeration, and Air Conditioning Engineers. 1995 (or the most recent edition).
Available from:
ASHRAE 110
1791 Tullie Circle, NE
Atlanta, GA 30329
ANSI/ASHRAE 110 111. “Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.” American Society of Heating, Refrigeration, and Air-Conditioning Engineers. 1988 (or the most recent edition).
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ANSI/AIHA Z9.2. “Fundamentals Governing the Design and Operation of Local Exhaust Systems. 2001(or the most recent edition).
Available from:
AIHA
2700 Prosperity Avenue, Suite 250
Fairfax, VA 22031
ANSI/AIHA Z9.5. “Laboratory Ventilation.” American Industrial Hygiene Association. 2003 (or the most recent edition).
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“Primary Containment for Biohazards: Selection, Installation, and Use of Biological Safety Cabinets.” U. S.Department of Health and Human Services. U. S. Government Printing Office. Washington, D.C. 1995 (or most recent edition).
“Prudent Practices in the Laboratory: Handling and Disposal of Chemicals.” Committee on Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories. National Academy Press, Washington, D.C. 1995 (or the most recent edition).
ANSI 305
UW-Madison Business Services – Fume Hood Procurement Contract:
http://www.bussvc.wisc.edu/purch/contract/wp5763.html

Appendix C – Fume Hood Performance Testing Guidelines

A. Fume Hood Performance Test Conditions

1. General room ventilating systems, both supply and exhaust, including fume hood exhaust, must meet FP&M & Division of State Facilities design specifications and shall be in full normal operation. Airflow systems in the laboratory shall be properly balanced and commissioned prior to this test. This includes calibration of airflow controls, calibration of automatic temperature controls, balance of supply air, etc. (“Prudent Practices for Handling Hazardous Chemicals in Laboratories,” 1995 and ANSI/ASHRAE 110 110-2006). Laboratories must be under negative pressure relative to corridor unless special design conditions prevail.
2. Hoods are tested in fully open position and As Used open position.

3. The hood being tested should be empty (new and renovated hoods only)
4. The doors to the laboratory will be closed.
5.. When adjustments are made to hood sashes, supply and exhaust air in the room will be allowed to stabilize before testing is done.
6. Hood monitor is calibrated and not in alarm.

B. Determination of Average Face Velocity as contained in the ANSI/AIHA Z-9.5 and ANSI/ASHRAE-110

Measuring fume hood velocity at individual grid points helps reveal how well a fume hood is working. Therefore, to make sure all employees use the same protocol, the following four points are provided:

1. Face velocity measurements shall be made by dividing the hood opening into equal area grids with the sides measuring no more that 12 inches. No less than nine (9) grid areas should be used.
2. The tip of the probe shall be positioned in the plane of the sash opening and fixed at the approximate center of each grid, (Holding a probe by hand creates the potential for error so the evaluator should use a fixed probe measurement (were feasible) and stand to the side so as to affect air flow as little as possible).
3. Face velocity readings shall be averaged over at least a ten second period; report the average and individual grid readings.
4. Face velocity measurements shall be made with an annually calibrated digital velocity meter (TSI) with an articulating (90 degree) probe tip, with a range of at least 40 to 400 feet per minute and accuracy of +/- 3.0% of the reading. The instrument should have a calibration label affixed to the hand held portion and certificate available.

C. Inspection & Performance Testing of Pioneer D.A.T. System

Due to past concerns of the UW testing representatives, the Pioneer D.A.T alarm operation should be verified before final installation of the fume hood (easier when hood is still on skid). To start this test, remove the plug from the receptacle on the roof of the hood that controls the D.A.T air system and plug it into a 120-volt receptacle at the job site. This will energize the D.A.T supply air system.

With the D.A.T alarm powered up and the vertical sash in the closed position, the sash monitor's green led should be illuminated. Raising the sash above 18 inches should engage the yellow led, and at 10-second intervals a beep (chirp type sound) will be heard. This is to let the user of the

hood know that the sash is raised above 18 inches and in this position; the D.A.T blower should be operational. If the D.A.T blower is not on, the electronic eye at the top left side of hood and located inside the sash enclosure should be inspected to see if the bracket has been compromised, which would not allow the sash to trigger the D.A.T blower. If the D.A.T blower runs all the time no matter the position of the sash, the electronic eye should be considered the prime problem. Check to see if the bracket is positioned correctly, and that the electronic eye is placed in the bracket correctly, and is functional.

If the D.A.T fan runs when the vertical sash is opened beyond 18 inches; the next step to perform is verify the operation of the alarm in case the D.A.T blower fails. Allow the D.A.T blower to run for 30 seconds, before performing the test (there is a delay built into the software to prevent unintended alarms before the blower has reached full speed). With the D.A.T blower running, close off the intake air to the D.A.T blower. With this accomplished the D.A.T alarm should engage in about 5 seconds. If the alarm does not engage after 15 seconds, the static pressure switch needs to be adjusted. With the D.A.T fan running, slowly turn the adjustment screw on the pressure switch clockwise, until the alarm engages. With the alarm sounding, reverse the rotation of the adjustment screw until the alarm no longer sounds off, and turn an extra ¼ to ½ turn (counter clockwise). After this, repeat the blocking off of the intake blower and verify the alarm engages in 5 to 10 seconds.

In case the alarm sounds almost immediately (red led illuminated) after the D.A.T system is powered up with the sash raised above 18-inches; then two things could be triggering the alarm. First, check the pressure switch, it may not of been adjusted properly at the factory, or the diaphragm could have been jiggled around during shipment. The remaining culprit could be the control board, which is housed in the Hoffman box located on the roof of the hood. Replace the

electrical board with another, and check to see if the D.A.T alarm is functioning correctly.
D. Smoke Testing To Determine Airflow and Turbulence
1. Using a smoke tube, puff smoke 6 inches within the face of the hood around the outside edge of the opening. Determine direction of smoke flow. If visible fumes flow out of the front of the hood, make necessary adjustments.
2. Ignite a smoke candle in the hood and visually observe if there is leakage of smoke from the ductwork or if smoke is being drawn back into building or surrounding buildings.
E. Conditions for Passing Hoods
1. General room ventilating systems, both supply and exhaust, including fume hood exhaust shall be in full normal operation.
2. Hood must have an acceptable face velocity and must pass the smoke testing.
3. No leakage of exhaust from ductwork.

Appendix D – Chemical Fume Hood Performance Test Report
Appendix E – Failure Notice

Appendix F – Evaluation Requirements for Procurement Consideration

A. General Guidelines
General guidelines on types of hoods and their application are presented in ACGIH's "Industrial Ventilation – A Manual of Recommended Practices" (most current edition). Laboratory fume hoods and associated exhaust ducts should be constructed of noncombustible, nonporous material that will resist corrosion. They should be equipped with vertical or horizontal sashes, air foils built into the fume hood at the bottom and the sides of the sash opening, and baffles to attain a uniform face velocity under different conditions of hood use. Combination horizontal and vertical sashes shall be provided unless special conditions dictate otherwise. Additionally, recognized design and construction features are listed in the ANSI/AIHA Z9.5-2003 standard titled, "Laboratory Ventilation," and ANSI/AIHA Z9.2-2001 standard, "Fundamentals Governing the Design and Operation of Local Exhaust Systems."
Fume hoods should be tested before a hood leaves the manufacturer using the ANSI/ASHRAE 110 110-2007 standard, "Method of Testing performance of Laboratory Fume Hoods." All new hoods shall meet the ANSI/ASHRAE 110 requirements for Class 1 hoods including a tracer gas performance of AM (as manufactured) 0.05 (parts per million) or better at a tracer gas release rate of 4.0 Liters per minute (lpm).
Documentation shall be provided with the results of the test. Performance is measured by specific tests:
• Flow visualization,
• Face velocity measurements,
• Test method for Variable Air Volume (VAV) fume hoods,
• VAV response test, and,
• Tracer gas containment.
Flow visualization qualitatively tests a hood's ability to contain vapors. This test consists of a small local challenge (use of a smoke tube), and a gross challenge (use of a smoke candle or smoke generator) to the hood.
Smoke is released into the hood to visually determine if a hood or associated duct has a leak.
Face velocity measurements determine the average velocity of air moving perpendicular to the hood face. The measurement is usually expressed in feet per minute (fpm). Face velocities will often provide information concerning the fume hood's ability to properly control contaminants. A tracer gas leak test will quantitatively determine if the fume hood is properly containing contaminants. A tracer gas is released in the hood and a continuous-reading instrument is positioned outside the hood to monitor the escape of the tracer gas. The preferred tracer gas is sulfur hexafluoride (SF_6).

B. Face Velocity

Each variable air volume hood shall maintain an average face velocity of 45--75 fpm (50 fpm optimum) at the maximum sash opening. Each constant volume hood shall maintain an average face velocity of 85--150 fpm (100 fpm optimum) in the As Used position. Face velocity measurements are to be made with a recently calibrated mechanical or electrical anemometer. Measurements, of 1 square foot areas, should be made across the face of the hood and no single face velocity measurement should be more than plus or minus 20% of the average. For further information, refer to ANSI/ASHRAE 110 111-1988, "Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems."

C. Face Velocity Monitoring

All fume hoods shall include some means of monitoring air flow with a visual and audio alarm. The Thermo Fisher Hamilton "Pioneer" fume hood shall also have a sash position alarm.

D. Supply Air

The proper volume, distribution, and quality of supply air shall be provided to laboratories containing fume hoods. ANSI/AIHA Z9.5 1992 and ANSI/ASHRAE 110 62 provide these standards. Make up air (replacement air) should be equal to at least 95% of the volume exhausted from the laboratory. This air shall not be recirculated from other laboratory areas. Although laboratory supply air seldom requires air cleaning, ASHRAE 110 (HVAC Application Handbook, 1995) provides technical information for the reduction of contamination from atmospheric dust and dirt.

Air supply systems for rooms containing chemical fume hoods shall not create room air drafts at the face of any hood greater than one half (and preferably one third) the face velocity of the hood. For most laboratory hoods, this means 50 fpm or less terminal throw velocity at 6 feet above the floor. ACGIH's "Industrial Ventilation - A Manual of Recommended Practice," provides design criteria to help achieve these standards. Room air change rate will be based on maintaining space temperature and desired room clearance time. If the building supply air can not control the space heating or cooling loads a re-circulating room supply air system can be installed as long as this air sully does not interfere with the fume hood(s).

E. Exhaust Stack Discharge and Exit Velocities

Exhaust stacks shall be designed and built to prevent recirculation of contaminated air from the fume hood exhaust system into the fresh air supply of the facility. Effluent exhaust shall escape the building envelope. The stack shall also provide significant effluent dispersal so that effluent downwash does not occur at ground level. They shall be designed and built with the latest applicable ANSI, ASHRAE 110, and AIHA standards. The "2001 ASHRAE 110 Fundamentals Handbook," and the publication titled, "Laboratory Stack Height Determination and Evaluation Methods," presents three methods for specification and evaluation of stack heights from laboratory hood exhaust fans.

Effluent discharge shall:

1. Direct to the atmosphere (unless treated for recirculation).
2. Conform to federal, state, and local air emission regulations.
3. Release so that reentry of effluent from the discharging building or a surrounding building is reduced to allowable concentrations inside of the building. (Allowable concentrations shall be determined using information on the nature of the contaminants to be released, recommended industrial hygiene practice, and applicable safety codes.)

Exhaust discharge from stacks shall:

1. Be in a vertical up-draft direction at a minimum of 10 ft above adjacent roof lines and located with respect to surrounding air inlets as to avoid contaminant reentry.
2. Have a minimum exit velocity of 3000 fpm.

APPENDIX G:

Memorandum

To: All UW-Madison Principal Investigators who utilize chemical fume hoods
Cc: College and School Representatives
Facility Managers
Facilities Planning & Management – Environment Health & Safety department
University Health Services – Environmental Health Program
Physical Plant Central Answering & Receiving (CARS)
From: UW-Madison Physical Plant
Re: Funding for Campus Fume Hood Performance Testing and Repairs

The UW-Madison campus fume hood program addresses the maintenance and safety requirements of campus fume hoods used for general laboratory chemical safety. Standard-flow fume hoods, high-performance fume hoods, and capture hoods that are utilized for this purpose are included in the scope of the campus fume hood program.

Beginning July 1, 2009 physical plant will assume funding support of the campus fume hood program through its maintenance operation. As such, funding support for performance testing and repairs of chemical fume hoods shall be provided in those buildings that are supported by the physical plant maintenance operation only.

Funding for performance testing and repairs in non-supported buildings shall be a departmental responsibility. Physical Plant shall request departmental funding support as needed in nonsupported buildings.

Please refer to attachment for additional information.