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Drexel University
Laboratory Fume Hood Program

I. Overview
A. Background
   In order to ensure the health and safety of students, faculty, and other employees in our teaching and research laboratories, the development of a standardized hood maintenance and testing procedure is mandated by the Occupational Health and Safety Administration's (OSHA's) Laboratory Standard (29 CFR 1910.1450). Although the Drexel University Safety Committee has done some research on the accepted methods for maintaining and testing laboratory fume hoods, much of this document has been liberally "borrowed" from the Harvard University hood maintenance and testing program written by Louis J. DiBerardinis. This should be viewed as recognition of the completeness of his work, rather than a lack of effort on the part of the administration of Drexel University or the members of the Safety Committee.

B. Periodic Review
   The ad hoc committee for laboratory fume hoods shall jointly review this document on an annual basis. The ad hoc committee shall include representation from the University Safety & Health Department, Facilities Management Department, and academic departments that utilize fume hoods.

II. Responsibilities
A. University Safety & Health Department
   The University Safety & Health Department will:
   - Perform an airflow survey on all university fume hoods at least annually.
   - Perform an airflow survey on laboratory fume hoods at the request of a user.
   - Report the results of any fume hood survey to the departmental Chemical Hygiene Officer in written form.
   - Report unsafe hoods to the user and Facilities Management Department immediately via fax 215-895-6754 and work order.
   - Perform a follow-up airflow survey promptly after appropriate repairs are completed on those fume hoods found unsafe.
   - Advise on the selection and installation of new fume hoods and advise on the relocation of existing hoods.
   - Perform an airflow survey on newly installed, renovated, or rebuilt/relocated fume hoods before they are used by the user.
   - Place a lockout device on fume hoods that are considered unsafe due to the airflow survey. The lockout device will be used to ensure the safety of the user and will remain in place until appropriate repairs are made.

B. University Facilities Management Department
   The University Facilities Management Department will:
• Within 24 hours of notification of an unsafe hood by a user, departmental Chemical Hygiene Officer or the Safety & Health Department, evaluate the hood system and make appropriate repairs. Upon completion of the repair, notify both the departmental Chemical Hygiene Officer and the Safety & Health Department that the hood is repaired. If the repair requires more than one working day to complete, the user must be notified that the hood is not repaired and should be apprised as to how long it will take to obtain parts, etc., and the hood should remained locked out.

• During maintenance, the hood should be locked and tagged out to indicate that the hood is undergoing maintenance.

• Facilities Management must advise on the selection and supervise installation of new and/or rebuilt fume hoods and approve the relocation of existing hoods.

• Follow the routine preventive maintenance, notification, and hood testing procedures described below.

C. Departmental Chemical Hygiene Officer (CHO)
The departmental Chemical Hygiene Officer (CHO) will:

• Report questionable operations of a laboratory fume hood to the Safety and Health and Facilities Management Departments.

• Post fume hood safety procedures on all fume hoods.

• Serve as the contact person for notification of any fume hood related issues.

• Consult with the Safety & Health and Physical Plant Departments before a new hood is ordered, installed, or an existing hood is renovated or relocated.

D. Laboratory Supervisor
The Laboratory Supervisor will:

• Ensure that the laboratory work carried out in the laboratory fume hood is appropriate for the type of hood available and the quality of ventilation present.

• Report questionable operation of a laboratory fume hood to the departmental CHO immediately.

E. Laboratory Hood User
The Laboratory Hood User will:

• Follow proper procedures when using the laboratory fume hood. See the article by Mikell and Fuller entitled "Good Hood Practices for Safe Hood Operation" and the American Chemical Society publication Safety in Academic Chemistry Laboratories, 5th ed., for suggestions on proper hood techniques.

• Report questionable operation of a laboratory fume hood to the departmental CHO immediately.

• Avoid using the hood for chemical storage.

III. Types of Fume Hoods:
The following information concerning types of laboratory fume hoods available is abstracted from the SAMA Standard for Laboratory Fume Hoods. The majority of laboratory
Fume hoods have one or two (depending on the size) vertical sliding sashes (i.e., they move up and down). Some hoods are equipped with horizontal sliding sashes (i.e., they move left and right).

A. Conventional Hood

All air enters through the hood opening as defined by the bottom of the sash, sides of the hood, and the work surface. As the viewing sash is lowered both the static pressure loss and air speed increase as the volume of air being exhausted decreases. High face velocities are to be expected with the sash in the near closed position.

B. Conventional Bypass Hood

Bypass-type fume hoods incorporate an automatic compensating opening which functions as the hood sash is closed. Air drawn through the bypass passes through the hood interior to dilute and exhaust generated fumes. The bypass limits the face velocity, increases and maintains a relatively constant exhaust volume as the hood sash is closed. The bypass is usually located directly above the hood sash.

C. Auxiliary Air (Induction) Hood

The auxiliary air system functions to reduce the consumption of conditioned room air.

- With the hood sash open, the auxiliary air shall be introduced exterior to the fume hood, enter the fume hood through the hood face, and be distributed across the face area prior to its passage into the hood.
- With the hood sash closed, the auxiliary air shall be introduced into the fume hood interior in such a manner as to aid in the dilution of heat and fumes generated in the work area.

Although the auxiliary air is brought directly from the outside of the laboratory building, provision should be made to condition the air during extremely hot or cold periods.

D. Radioactive Hood

Any of the above hoods can be used for radioactive materials, provided that:

- The fume hood is properly labeled prior to use with radioactive materials.
- The interior work surfaces should be constructed from non-porous or sealed materials that preclude adsorption of radioactive material and shall resist the corrosive action of chemicals used in this work (usually means use of stainless steel). All seams and joints in the work surface and superstructure should be welded, sealed or soldered to eliminate pockets, cracks or crevices that would permit a buildup of radioactive materials.
- The work surface shall be watertight and dished or furnished with a raised bar across the front edge to contain spills and cleaning liquids.
- The work surface should be properly reinforced to support lead shielding and shielded containers. The load bearing capacity shall be 200-pounds/square foot minimum up to a total weight of 1000 pounds per fume hood.
- Some types of radioactive materials require a filter at the hood outlet; these should be regularly inspected by the University Radiation Safety Officer.
E. Perchloric Acid Hood

Laboratory fume hoods for use with perchloric acid shall be identified with a label indicating suitability for use with perchloric acid procedures. Any of the above hoods can be used for perchloric acid, provided:

- All exposed parts of the fume hood interior are suitable for use with perchloric acid.
- The work surface is watertight and dished or furnished with a raised bar to contain spills and wash-down water.
- The hood is outfitted with a water wash-down system for rinsing the area behind the baffle.
- The baffle should be removable to allow periodic inspection.

Use of small quantities (<2 ml) of perchloric acid at room temperature (no heating) does not require a wash-down facility. If large quantities of perchloric acid must be used (or solutions must be heated), a specially constructed perchloric acid hood should be utilized.

F. Glove Box

This is a sealed enclosure used to confine and contain hazardous materials with operator access through gloved portals or other limited openings (such as a pass-through chamber). It is not a fume hood, and it is not to be used for storage of volatile chemicals.

G. Biological Safety Cabinet

This is used for the handling of pathogenic micro-organisms, it is not a chemical fume hood. Only small amounts of non-volatile chemicals should be utilized in these cabinets. These cabinets must be tested in different ways as appropriate for their specialized use.

H. Specially Designed Systems

These include walk-in hoods or local exhaust capture hoods (sometimes referred to as "elephant trunks").

IV. Preventive Maintenance

Only appropriately trained Building Systems personnel of the Facilities Management Department should carry out repairs or preventive maintenance. As the laboratory fume hood is a critical piece of laboratory safety equipment, fume hoods must not be turned off prior to notification of the laboratory supervisor or departmental CHO (see the section on communication below for proper notification procedures. The worker should verify that the hood is not in use and follow the standard Lockout/Tagout procedures prior to performing the work.

The following maintenance tasks should be performed on an annual basis:

- Remove all corrosion, spot prime and paint.
- Inspect electrical connections, tighten as required.
- Inspect motor control contacts for wear or pitting, replace as needed.
- Tighten all terminal lugs.
- Replace the drive belt as needed.
The Facilities Management Department will keep records of the preventative maintenance checks performed on all laboratory fume hoods. A report of the hoods checked during the preventative maintenance work will be forwarded to the University Safety & Health Department.

V. Routine Surveys of Chemical Fume Hood Performance

A. Hood Performance Testing

The final version of the Laboratory Standard\(^1\) requires that employers incorporate into their Chemical Hygiene Plan measures to assure the proper functioning of fume hoods and other safety equipment. However, the final standard does not specify face velocities for fume hoods. Briefly, OSHA recognizes that there is considerable debate over what optimum velocities should be in light of differences in hood design and methods of operation. Moreover, it was felt that requiring specific face velocities was not consistent with the performance orientation of the standard. In order to facilitate routine surveys of hood performance, a numerical method for evaluating hood performance using face velocity measurements is given below. However, the second test, involving visualization of the flow patterns within the fume hood is recommended whenever possible.

1. Numerical testing procedure

The linear flowrate into the hood should be measured with a calibrated velometer (e.g. Alnor Thermometer). The following procedure is employed\(^2,5\):

- The hood sash is adjusted to yield a hood opening of 15 inches.
- The resulting rectangular work opening is divided into three vertical zones.
- The velometer is used to measure the linear flow rate at a height of 3 inches and 11 inches above the hood floor in each zone. The inlet for the velometer should be located 1 inch behind the plane defined by the hood sash.
- For the hood to be considered safe and pass, the average of the six measurements must equal or exceed 80 linear feet/minute. If the average of the six measurements is below 80 linear feet/minute, the hood is considered unsafe and the laboratory user(s), departmental CHO, and Facilities Management Department should be notified. In addition, a lock along with a danger tag will be placed on the hood to prohibit its use.

2. Flow Visualization:

If there is any doubt as to the containment efficiency of the fume hood (without regard to the results of the numerical testing procedure described above), a flow visualization method may be employed using smoke tubes. The University Health & Safety Department or the departmental CHO may perform this test. The purpose of the test is simply to observe if there is flow within the hood. Typically, the test should be performed at the safe hood sash opening height.

3. ANSI/ASHRAE 1995-110 Standard Method:

The ANSI/ASHRAE 1995-110-performance test gives a relative and quantitative determination of the efficiency of the hood containment under a conditioned environment. This method involves releasing a small amount of a tracer gas (either sulfur hexafluoride, or a gas of similar molecular weight and stability) at a fixed rate within the laboratory fume hood, while monitoring the concentration of the tracer material observed in the user's breathing zone using
highly specialized testing equipment. It is the opinion of Drexel's ad-hoc committee on Fume Hood Testing that the two test methods outlined above are both adequate and economical alternatives until the ANSI/ASHRAE method can be instituted.

B. Hood Failure

If any of the above tests indicate inadequate hood performance, the following steps should be taken immediately:

- The hood is prominently tagged with a label indicating that it is unsafe and should not be used (see appendix A). The hood should be locked out using a lockout device (available from the University Safety & Health Department) to prohibit use.
- Notify the departmental CHO responsible for the hood by telephone and/or electronic mail.
- Notify the Facilities Management Department using a work order request via fax (215-895-6754) or interoffice mail.

C. Energy Conservation:

Increasing energy costs and a renewed emphasis on energy conservation have caused fume hood designers, users, and building managers to review fume hood air consumption and to make efforts to reduce the air volume requirements. Since the primary purpose of the laboratory fume hood is safety, any revisions or changes in the volumetric flowrate must not compromise this principle. Safety is the most important consideration, regardless of energy consumption. However, some acceptable energy conservation procedures include:

- Use of reduced sash heights: Chemical fume hoods are designed so that they may be safely used with the vertical sash in the full open position. Decreasing the safe sash opening height (as described in the testing procedures above) may reduce the volumetric flowrate through the hood. All laboratory workers should be made aware of the appropriate safe hood sash opening height, preferably through use of stickers attached directly to each hood. In addition, note that the hood sashes should be minimally closed to chest height to protect the user's breathing zone.
- Careful selection of face velocities: If the safe sash height opening is less than the fully opened position, the blower motors may be adjusted to reduce the volume of air exhausted. Excessive velocities may actually hamper fume hood function due to production of turbulent flow patterns within the fume hood.
- Reduced operating hours: Unused hoods should be turned off by laboratory users. However, hoods must be run when there is the possibility of any fumes being present. Hood operation must be under the control of the user.
- Auxiliary air (Induction) hoods: The use of auxiliary air hoods reduces the consumption of expensive conditioned air and can result in energy savings of up to 75%. However, the air supply must be tempered for operator comfort and acceptable hood performance. Any planning for new laboratory construction or renovation should consider the use of auxiliary air hoods.
VI. Recordkeeping and Labeling

The hood testing survey form (see Appendix A) should be used whenever the hood performance is evaluated. The University Safety & Health Department retains copies of these reports and may analyze them in order to uncover trends in hood performance.

In order to facilitate the notification of departmental users, all fume hoods as well as the hood blower motors in the building mechanical rooms should be clearly labeled with hood equipment numbers and room locations. The labels will indicate the building number, room location and fume hood number (i.e., 12-204-1 would indicate the first fume hood in Disque Hall room 204). These tags should be updated whenever a laboratory hood is added, relocated or removed.

VII. Communication

Communication is critical in any integrated hood safety program. The hood user shall be notified (through the laboratory supervisor or departmental CHO) in advance of any scheduled preventive maintenance work, in order to enable chemical reactions to be finished and/or materials to be removed from the hood as is appropriate. This will protect both the laboratory user as well as the maintenance worker from unnecessary exposure to any hazardous chemicals. If any hood is found to be unsafe during a routine maintenance check or annual hood performance survey, the hood will be tagged "Unsafe, Do Not Use" and will be locked out. After the hood survey, the departmental CHO and the Facilities Management Department will be notified in writing regarding the status of laboratory fume hoods in that department. The departmental CHO will forward copies of the reports to the individual laboratory supervisors.

VIII. Training & Education

Laboratory hood users will be trained on the use and safe work practices to be employed prior to their initial involvement in Drexel laboratories. The training will discuss laboratory safety procedures and precautions to take while working in laboratories. A copy of the American Conference of Governmental Industrial Hygienists (ACGIH) Work Practices For Laboratory Hoods (or similar) should be posted on all fume hoods (see Appendix B). Safe work practices will also be reviewed during department safety training. A list of the individuals trained and dates of the training sessions shall be maintained by the respective department.

IX. Revision History

Original draft: final policy issued 5/6/91, accepted 9/14/91
First revision: final policy issued 7/26/94
Second revision: final policy issued 1/98 (Safety & Health Dept. Revision)

X. References


XI. Appendix A

A. Hood Testing Tag

Hood ID Number: ____________ Bldg/Room: ______________

Average flow rate (15 inch opening): ______ linear FPM
Lowest flow rate: ______ linear FPM

Hood Usage: ___ Unlimited Use
              ___ Use Prohibited

Tested by: ________________ Testing date: ____/____/____

Drexel University Safety & Health Department

B. Blower/Motor Assembly Tag

Hood ID Number: ____________ Bldg/Room: ______________
Department: ______________

Before servicing this hood motor/blower assembly, notify the following persons:

Departmental CHO: ________________________ phone: __________________
Lab Supervisor: ________________________ phone: __________________

Drexel University Facilities Management Department Date: ____/____/____
C. Hood Testing Worksheet

Hood ID Number ___________ Bldg/Room: ___________

Hood linear flowrate measurement grid:

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Measurements are made with the hood sash open 15 inches.

Average flow rate (15 inch opening): ________ linear FPM

Hood Usage:  ___ Unlimited Use  >80 LFPM at 15 inch sash opening
            ___ Use Prohibited  <80 LFPM at 15 inch sash opening

No one flow rate measurement should be more than 20% different from the average. If one or more measurements is more than 20% different, use of the hood is restricted until the hood baffle or user's equipment in the hood are repositioned to allow an even flow pattern to be achieved.

Tested by: ________________ Testing date: ___/___/___
D. Unsafe Hood Warning Tag

=====================================================================
WARNING
THIS HOOD IS UNSAFE

This fume hood does not meet the minimum flowrate of 80 linear feet per minute at a minimum sash opening height of 15 inches. Further use of this hood is prohibited until the cause of the problem is found and appropriate repairs are completed. Inquiries concerning the status of the hood repair should be addressed to the Facilities Management Department at 215-895-2825.

Bldg/Room: _________________  Hood ID Number: __________
Tested by: _________________  Testing date: ____/____/____

Drexel University Facilities Management Department

--------------------------------------------------------------------
E. Hood Maintenance Tag

=====================================================================
WARNING
THIS HOOD IS TEMPORARILY OUT OF SERVICE FOR MAINTENANCE

This fume hood is temporarily out of service for maintenance. Use of this fume hood is prohibited until these repairs are completed. Inquiries concerning the status of the hood repair should be addressed to the Facilities Management Department at 215-895-2825.

Bldg/Room: _________________  Hood ID Number: __________
Tested by: _________________  Service date: ____/____/____

Drexel University Facilities Management Department
XII. Appendix B

Safe Work Practices for Laboratory Chemical Fume Hoods

No large open face hood with a low face velocity can provide complete safety against all events that may occur in the hood, nor provide protection for volatile airborne contaminants with a threshold limit value (TLV) in the low parts per billion range. For more ordinary exposures, a well-designed hood in a properly ventilated laboratory can provide adequate protection. However, certain work practices are necessary in order for the hood to perform capably. The following work practices are generally required; more stringent practices may be necessary under some circumstances.

- Conduct all operations that may generate air contaminants at or above the appropriate TLV inside a hood.
- Keep all apparatus at least 6 inches back from the face of the hood. A stripe on the bench surface is a good reminder.
- Users should keep their faces outside the plane of the hood sash.
- Hood sash openings should be kept to a minimum. Hoods are tested (and should be used) with a hood sash opening of 15 inches.
- Do not use the hood as a waste disposal mechanism except for small quantities (<10 mL) of volatile materials.
- Do not store chemicals or apparatus in the hood. Store chemicals in an approved safety storage cabinet.
- Keep the slots in the hood baffle free of obstruction by apparatus or containers.
- Minimize foot traffic past the face of the hood to prevent disruptions in air flow.
- Keep laboratory doors closed when working in the hood.
- Traps, scrubbers or incinerators should be used to prevent toxic and/or noxious materials from being vented into the hood exhaust system.
- Do not place electrical receptacles or other spark sources inside the hood when flammable liquids or gases are present. No permanent electrical receptacles are permitted in the hood.
- Use an appropriate barricade (e.g. a blast shield) if there is a chance of explosion or implosion.
- Remain alert to changes in air flow.
- Do not remove hood sash or panels except when necessary for apparatus set-up; replace the sash or panels before operating.
- Exhaust ports from the hood and supply air vents to the room (Nesbitt units or unit ventilators) should not be blocked.
• Prepare a plan of action in case of an emergency, e.g., a power failure.
• To save energy, turn off the blower and close the hood sash when the hood is not in use.

**Useful References**


