NATIONAL ACCELERATOR LABORATORY

ENVIRONMENT, SAFETY & HEALTH DIVISION

Chapter 53: Chemical Safety

Hazard Control Ventilation Requirements

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1 Purpose

The purpose of these requirements is to protect workers from airborne concentrations of potentially harmful contaminants. They cover the installation, use, performance, and monitoring of hazard control ventilation equipment. They apply to workers (as *chemical workers*), supervisors, *principal investigators*, *laboratory managers*, ESH coordinators, area and building managers, the chemical safety program manager, Occupational Health, ESH, and Facilities and Operations.

These requirements comply with regulatory standards for mechanical ventilation systems (8 CCR 5143 and 8 CCR 5154.1). They are to be reviewed annually by the chemical safety program manager.

2 Requirements

Hazard control ventilation systems are commonly relied on as a primary engineering control in industrial operations, maintenance activities, and laboratory operations. Local exhaust ventilation hoods and points for operations must be used to ensure sufficient reduction of airborne concentrations of contaminants that could pose a risk to personnel. Local exhaust points include fume hoods, extractor arms, glove boxes, biological safety cabinets, and other exhausted equipment enclosures that perform a safety or health function.

2.1 Activities Requiring Local Exhaust Ventilation

Activities requiring local exhaust ventilation include

- Using particularly hazardous substances (such as acutely toxic, carcinogenic, or reproductive toxins)
- Performing operations that could expose workers to more than 10 percent of either an *action level* or, if no action level exists, an *occupational exposure limit (OEL)*
- Handling toxic substances in an enclosed area
- Handling volatile, flammable liquids that could generate a flammable atmosphere
- Conducting procedures that generate airborne particulates (dust) or liquid aerosols of even moderately toxic chemicals
- Using pungent or noxious odiferous compounds
- Handling concentrated acids or bases

Note *Operations involving heating or evaporating perchloric acid must be evaluated by the ESH coordinator and lab manager to determine whether special controls (such as using an acid fume hood with wash-down systems to prevent the accumulation of explosive perchlorate crystals) are needed.*

- Discharging gases/vapors from vacuum pumps and distillation columns
- Discharging harmful gases and vapors from drying ovens and muffle furnaces
- Discharging an oxygen-displacing gas or liquid into a space at levels that create an *oxygen deficiency hazard (ODH)*, as described in Chapter 36, "Cryogenic and Oxygen Deficiency Hazard Safety"
- Handling biohazard agents or biohazardous materials per Chapter 34, "Biosafety"

Important Self-contained (ductless) hoods that recirculate air back into the workspace have *extremely* limited applications, and are not an acceptable means to control exposure to hazardous materials.

Figure 1 Laboratory Fume Hood

2.2 Installation and Use

When hazard control ventilation systems are planned for installation, ESH must be consulted to ensure proper selection and installation. Ventilation performance criteria will be defined by ESH based on regulatory requirements. The selection, procurement, installation, and balancing of all ventilation systems must be discussed with the ESH coordinator, area or lab manager, and building manager before making a decision on the appropriate selection. Each hazard control ventilation system must have a designated custodian (see Chemical Lifecycle Management: Chemical Storage Asset Requirements, and Ventilated Lab Hoods).

2.3 Ventilated Laboratory Fume Hoods

A ventilated laboratory hood is designed to protect workers from the hazards of airborne contaminants. Hoods also help protect people and property against small fires and explosions. (For an inventory of ventilated lab hoods at SLAC, see Ventilated Lab Hoods.)

The following precautions should be taken to ensure fume hood function is not compromised:

- Prior to installation, consider cross-drafts associated with proximity to traffic, supply air diffusers, windows and doors.
- Do not place large equipment in front of ventilation hoods or system intakes as this could restrict air flow and reduce ventilation efficiency.
- Ensure the ventilation system is rated for the intended operation.
- Confirm the system is operational before using; check that fan is powered on and airflow conforms to required parameters.
- Keep the hood sash or slide gate damper set at the approved level or set point to maintain adequate ventilation rate.
- Do not block airflow to baffles with equipment or chemicals; restricting air flow or creating a fire hazard.
- Ensure all open chemical handling is positioned at least 6 inches from the sash opening.

2.4 Biosafety Cabinets

Biosafety cabinets are ventilated cabinets that are required for the containment of biohazard agents or biohazardous materials and may be used to control harmful exposure to aerosols and particulate matter. (See Chapter 34, “Biosafety”.)

2.5 Gas Cabinets

Gas cabinets are typically required for flammable, toxic, corrosive, or pyrophoric gases. Guidance on procurement and installation of gas cabinets can be found at Gas Cabinet Guidance. Fume hoods may be used for this purpose as well, based on review and concurrence from the ESH coordinator.

2.6 Other Ventilation Systems

Other hazard control ventilation systems may include local exhaust points, soldering bench hoods, extractor arms, ventilated chemical storage cabinets, snorkels, canopies, glove boxes, and equipment enclosures. Typical face velocities for ventilation systems can be found in *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards*.

For facilities-related ventilation systems, such as those in use in the electroplating, welding, and paint shops, Industrial Hygiene evaluates equipment for adequate contaminant control and ventilation performance. Ventilation performance for many of these systems is subject to state regulatory requirements.

Figure 2 Glove Box

2.6.1 Inert Atmosphere Equipment

Glove boxes and Schlenk lines that provide a non-reactive atmosphere are typically required for operations involving moisture- or air-reactive substances, such as pyrophoric materials. Fume hoods may also be used provided that measures are taken to control moisture and/or air.

2.6.2 Chemical Storage Cabinets

New flammable storage cabinets must comply with Chemical Lifecycle Management: Chemical Storage Asset Requirements. Existing flammable storage cabinets showing signs of interior corrosion or whose contents produce strong odors during storage should be ventilated.

New corrosive storage cabinets should be connected to the building's exhaust system. Existing cabinets may also need to be connected if they show signs of corrosion or produce odors.

2.7 Ventilation System Performance Standards

Figure 3 Quantitative Airflow Monitor and Testing Record Sticker

New local exhaust ventilation systems and hoods must meet the requirements of building and fire codes and regulatory standards. Facilities and Operations is responsible for ensuring proper installation, balancing, and function testing all new ventilation devices that are part of a construction project. ESH ensures documented annual testing of all fume hoods, biosafety cabinets, and gas cabinets.

2.7.1 All Ventilation Systems

2.7.1.1 Testing

The ventilation rate of all hazard control ventilation systems that prevent harmful exposures must be tested annually and after installation, modification, or maintenance (8 CCR 5143(a)(5)). Additionally, ventilation system owners can request a performance check on the unit when there is a change in operation, or when there is a suspected air flow issue. Performance checks can be obtained by contacting the ESH coordinator or Industrial Hygiene.

2.7.1.2 Labeling

The technician performing the tests records the results of the ventilation tests by updating the sticker attached to the system, usually at the point of use. The information on the sticker includes the name or initials of the tester, the test date, the measured flow rate, and the pass/fail result of the qualitative test. A sticker or other marking must also indicates the proper alignment of the sash or slide gate damper (as applicable) to ensure adequate airflow. The results of calibrations, tests, and certifications are recorded in a database maintained by Industrial Hygiene and the chemical safety program manager.

2.7.1.3 Failure

If the airflow sensor alarm is activated (red light, warning sound) or the airflow rate falls below the indicated set point, work in that system must be discontinued and the custodian and/or ESH coordinator contacted to report the condition.

Warning Do not simply mute the alarm and continue working: the alarm indicates that something is not operating correctly.

Upon testing, if a ventilation system fails to meet the minimum performance standard, ESH will send a report to the system's custodian. It is the responsibility of the custodian to ensure that the deficient ventilation system is repaired and is not used until that time. Until the deficiency is corrected, the custodian will mark the system with a warning sign and effectively restrict activities as needed to prevent personnel over-exposure to contaminants.

2.7.2 Laboratory Fume Hoods

2.7.2.1 Ventilation Rates

All laboratory fume hoods must maintain an average face velocity of at least 100 feet per minute (fpm) with a minimum of 70 fpm at any point (8 CCR 5154.1(c)).

When no employee is present in the work area, fume hood average face velocity may be reduced as low as 60 fpm, provided following additional conditions are met:

1. Face velocity is decreased and increased via an automated system.

2. Each fume hood has undergone and passed ASHRAE 110 testing at the reduced flow rate.
3. ASHRAE 110 testing records and configuration are maintained for the life of the hood and five years thereafter.

2.7.2.2 Airflow Monitoring and Testing

Each hood must have a quantitative airflow monitor that continuously displays the hood's performance to the user. The monitor may either display the inward flow rate or provide an alarm that signals when airflow has dropped under 80 fpm. The alarm may be audible or visual (8 CCR 5154.1(e)(3)(A)).

Qualitative tests must be performed that demonstrate the hood's ability to maintain an inward flow, such as smoke tests. Tests must to be performed after installation and annually. Alternatively, qualitative testing frequency may be reduced to every two years if there is a calibration and maintenance program in place for the quantitative monitor or alarm system (8 CCR 5154.1 (e)(3)(B)).

2.7.3 Biosafety Cabinets

Biosafety cabinet (BSC) types are classified as Class I, Class II type A, Class II type B1, Class II type B2, Class II type B3, and Class III. (See Chapter 34, "Biosafety".)

2.7.3.1 Ventilation Rates

Each class of biosafety cabinets is subject to ventilation operational requirements as outlined below (8 CCR 5154.2(e)):

- Class I and Class II type A must provide a minimum inward average face velocity of 75 linear fpm at the work opening.
- Class II type B1, B2, and B3 must provide a minimum inward average face velocity of at least 100 linear fpm at the work opening.
- Class III must provide sufficient air flow to constantly purge the work area of hazardous vapors, gases or particulate generated within the cabinet. The air change rate must be at least one air change per three minutes or sufficient to dilute flammable dusts, gases, or vapors to below 20 percent of the *lower explosive limit (LEL)*, whichever is greater. The BSC must maintain a minimum negative pressure inside the cabinet of 0.5 inches of water.

2.7.3.2 Additional Testing Requirements

For Class I and Class II BSCs, a qualitative test must be performed that demonstrate the BSC's ability to maintain an inward flow, such as smoke tests.

For all BSCs, a quantitative aerosol challenge test must be performed on each high-efficiency particulate air (HEPA) filter. The test must be capable of detecting penetrations exceeding 0.005 percent of particles 0.3 micrometers or larger. Penetrations exceeding 0.03 percent constitute test failure.

2.7.4 Gas Cabinets

As described in Gas Cabinet Guidance, "the minimum average face velocity shall not be less than 200 feet per minute (fpm) or 150 fpm at any point across the access port".

2.7.5 Laboratory Room Exhaust

In *chemical laboratories*, laboratory heating, ventilating, and air conditioning (HVAC) systems should provide 100 percent outside air to laboratory spaces; recirculation of air should not be permitted. The HVAC systems should be balanced to keep laboratory spaces at a negative pressure relative to adjacent offices and hallways. This ensures that vapors, gases, fumes, and particulates do not migrate to non-laboratory spaces. A minimum of 6–12 air changes per hour in laboratory areas is recommended.

Laboratories may operate at positive pressure if their research function is adversely affected by ambient air drawn into the workspace and the risks posed by hazardous material release from the laboratory to adjacent areas are low. Clean rooms and laser laboratories are common examples of laboratories that operate at positive pressure.

2.8 Exceptions

Existing installations that were in compliance prior to the effective date of new safety orders are exempt from the performance standard requirements listed in this document, unless otherwise determined due to hazard severity (8 CCR 3202(b)).

2.9 Training

All personnel must receive equipment training on hazard control ventilation devices that includes

- Safe use of the equipment and its features, including an understanding of airflow, monitor readings, alarms, and relevant signage and postings
- Consequences of improper use, including hazardous material release and personnel exposure
- Procedure in the event of a power outage or other system failure

Supervisors ensure these training requirements are met.

3 Forms

The following forms and systems are required by these requirements:

- A test record sticker must be attached to each system, and include the name of the tester, the test date, the measured flow rate, and the pass/fail result of the qualitative test.
- Ventilated Lab Hoods. A database listing fume hood and biosafety cabinets and their performance testing records

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- Each hazard control ventilation system must have a designated custodian, the names of whom are maintained in the Ventilated Lab Hoods database by Industrial Hygiene and the chemical safety program manager.
- The technician performing the ventilation and airflow tests records the results by updating the sticker attached to the system, usually at the point of use. The information on the sticker includes the name of the tester, the test date, the measured flow rate, and the pass/fail result of the qualitative test. A sticker or other marking must also indicates the proper alignment of the sash or slide gate damper (as applicable) to ensure adequate airflow.
- The results of all calibrations, tests, and certifications are recorded in the Ventilated Lab Hoods database maintained by Industrial Hygiene. Hazard control ventilation system test records must be retained for at least five years.

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 53, "Chemical Safety"
  - Chemical Safety Program Site (SharePoint)
- Chapter 34, "Biosafety"
- Chapter 36, "Cryogenic and Oxygen Deficiency Hazard Safety"
- Chapter 40, "Chemical Lifecycle Management"
  - Chemical Lifecycle Management: Planning Requirements (SLAC-I-730-0A09S-039)
  - Chemical Lifecycle Management: Chemical Storage Asset Requirements (SLAC-I-730-0A09S-018)
- Chapter 58, "Laboratory Safety"

Other SLAC Documents

- Chemical Management Services (CMS)
- Gas Cabinet Guidance

Other Documents

- Title 8, *California Code of Regulations*, "Industrial Relations", Division 1, "Department of Industrial Relations", Chapter 4, "Division of Industrial Safety", Subchapter 7, "General Industry Safety Orders", Group 1, "General Physical Conditions and Structures Orders, Introduction", Section 3202, "Application" (8 CCR 3202)
- Title 8, *California Code of Regulations*, "Industrial Relations", Division 1, "Department of Industrial Relations", Chapter 4, "Division of Industrial Safety", Subchapter 7, "General Industry Safety Orders", Group 16, "Control of Hazardous Substances", Article 107, "Dusts, Fumes, Mists, Vapors and Gases" (8 CCR 5139–5155)
  - Section 5143, "General Requirements for Mechanical Ventilation Systems (8 CCR 5143)
  - Section 5154.1, "Ventilation Requirements for Laboratory-Type Hood Operations (8 CCR 5154.1)
  - Section 5154.2, " Ventilation Requirements for Biological Safety Cabinets" (8 CCR 5154.2)

- National Research Council. *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards* (Prudent Practices)
- Stanford University, Department of Environmental Health and Safety. Lab Safety
- Stanford University, Department of Environmental Health and Safety. Chemical Hygiene Plan