TECHNICAL BULLETIN

SCIENCE LABORATORIES AND INDOOR AIR QUALITY IN SCHOOLS

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March 1994
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Introduction

Science laboratories are extremely effective learning and motivational centers within schools. The science teacher is able to incorporate a wide range of interesting classroom demonstrations and "hands-on" experiments into the curriculum. These demonstrations and experiments create an exciting environment where the students take an active role in their own education. However, this same environment also contains numerous potential pollutants that may adversely impact the indoor air quality in the laboratories, and possibly other portions of the school.

The purpose of this bulletin is to provide school personnel with an overview of some of the potential indoor air quality (IAQ) problems presented by science laboratories in schools. The publication delineates good professional guidelines, and the various regulatory standards that will minimize the potential for adverse IAQ-related impacts on the school population. The focus of this bulletin is IAQ: it is not intended to cover all aspects of laboratory safety. However, many of the concepts presented herein will augment and reinforce the policies and practices found in laboratory safety manuals.

Laboratories as Contaminant Sources

Most laboratories contain a wide variety of chemicals that are used in instruction. These chemical substances can pose a number of potential IAQ-related problems when released into the school environment. The materials can become airborne by evaporation (at room temperature or at elevated temperatures by the addition of heat), by the generation of dust particles, and by release of gases, aerosols, and fumes by combustion and other chemical reactions. The potential health effects associated with laboratory chemicals range from noxious and irritating odors to serious acute respiratory effects and chronic disease or injury.

It is not feasible to discuss, or even list, all of the chemicals that may be found in school laboratories. School systems should use the least hazardous chemicals whenever possible and eliminate carcinogenic, highly toxic, and highly reactive chemicals from all laboratories unless there is some overriding educational benefit. A properly completed Material Safety Data Sheet (MSDS) will note if the chemical has been listed as a carcinogen by any national or international authority. The MSDS will also provide numerical (0, 1, 2, 3, or 4) ratings for health, flammability, and reactivity according to the National Fire Protection Association's (NFPA) Standard 704. Ratings of 3 or 4 in any of these categories should be considered "highly" hazardous.

Additional substances that may be found in laboratories are asbestos, pesticides, and radiological materials. Asbestos was routinely used as an insulating material in some laboratory hoods and instrumentation and was bound to the center of wire gauze squares (typically used to support beakers on a ring stand when heating with a burner). Pesticides may be used in greenhouses, and some advanced laboratories may use small quantities of certain radioisotopes.

Biological organisms are often overlooked as sources of air contaminants. Many science programs are becoming quite sophisticated in their biological sciences curricula. Some advanced courses involve extensive experiments in microbiology that can introduce a variety of plants (flowers, mushrooms, etc.) and microbial organisms (e.g., fungi) into the school. Some of these plants may be outright toxic, while others may produce allergenic spores which can become airborne. Likewise, pathogenic and non-pathogenic microbiological organisms may be cultured, intentionally or unintentionally, in the laboratory and spread to other parts of the school facility if proper procedures are not used.

In response to students' interest in animals, it is not uncommon to find environmental science classrooms that have numerous cages, aquaria, and terraria housing many mammals, fish, reptiles, and other forms of animal life. Great care must be taken to ensure that the animals and their cages, bedding, etc. do not become reservoirs of disease-carrying parasites and infectious agents. Also, a wide variety of animal hair and dander may cause allergic reactions (respiratory and skin) in teachers and students. Insect parts may also cause allergic reactions.

It is recommended that school laboratories use and house only animals that have been obtained from a scientific supply house. All wild animals should be excluded from schools.

Comfort and Health Effects

Exposures to indoor air pollutants and their ensuing health effects are generally classified as acute or chronic. Acute exposure to a chemical is usually measured in minutes or, in some cases, seconds. Acute health effects are those manifested almost immediately (e.g., irritation of mucous membranes, cough). Chronic exposure to a chemical refers to a repeated exposure over a long duration, usually measured in days, months, or years. Chronic health effects are those that develop and persist over time (e.g., cancers, liver and kidney effects) and, therefore, their appearance may not coincide with exposure to the causative agent(s).

The most common adverse health responses associated with poor IAQ are often subtle and not always immediately linked to indoor air contamination. The symptoms reported are often non-specific rather than clearly defined illnesses. Typical IAQ-attributed symptoms include headache, fatigue, cough, sneezing, dizziness, nausea, and irritation of the eyes, nose, throat, and skin.

A wide variety of pollutants may be associated with laboratories. Depending on the quantities released and the duration of exposure, these contaminants can produce a range of health effects and symptoms.

There is no clear division between physical discomfort and the onset of health symptoms, or between the perception of odors and irritant effects. However, as odors become stronger, more and more people will experience olfactory irritation which will eventually be manifested in IAQ symptoms. Individuals' responses to odors vary widely. Some people are extremely sensitive to certain odors and will find almost any level objectionable and discomforting.

Researchers have found that it is virtually impossible to identify temperature ranges that all segments of the population find comfortable. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) developed a "comfort chart" that describes ranges of temperature and humidity that should be acceptable to approximately 80% of the population. Spaces below 68 degrees Fahrenheit and 30% relative humidity in the winter, and above 78 degrees Fahrenheit and approximately 60% relative humidity in the summer are expected to produce discomfort in larger portions of the school population. Low relative humidity environments dry out the skin and mucous membranes, and high humidity limits the body's ability to shed excess heat. High humidity is also conducive to mold growth. Temperatures in laboratories may increase due to the operation of heat sources (ovens, burners, etc.), and humidity may rise because of a nearby greenhouse.

Exposure Standards

There are few air contaminant levels specifically established for children in schools. Human exposure guidelines for a number of air pollutants have, however, been established in regulations or recommended for other environments by various governmental agencies and professional organizations. Differences between guidelines usually stem from the assumptions about the population each guideline is intended to protect. For example, air contaminant limits for the industrial workplace are comparatively high since they are intended to protect a relatively healthy, adult workforce, are not intended to protect the more sensitive individuals, and assume little or no exposure to the contaminant beyond the normal 40-hour work week.

The occupational Safety and Health Administration (OSHA) regulates workplace exposure to many laboratory chemicals through the use of Permissible Exposure Limits (PELs). The National Institute for Occupational Safety and Health (NIOSH) performs health effects research and studies, then makes recommendations to OSHA for new regulations based on their work. The OSHA PELs and NIOSH recommendations are contained in Department of Health and Human Services (NIOSH) Publication no. 90-117, "Pocket Guide to Chemical Hazards," available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

The American Conference of Governmental Industrial Hygienists (ACGIH) annually publishes a list of Threshold Limit Values (TLVs) to be used as guidelines for the control of potential health hazards in the workplace, including those found in laboratories. The original OSHA PELs were based on the 1968 list of TLVs. TLV booklets are available from ACGIH, Technical Information Office, 1339 Kemper Meadow Drive, Cincinnati, OH 45240.

Other organizations and regulatory bodies have developed approaches for assessing non-industrial workplace exposures.
These are summarized below.

- ASHRAE Standard 62-1989 summarizes IAQ exposure guidelines and applicable standards used in the U.S. and Canada and consensus guidelines published by the World Health Organization. Appendix C of this standard recommends that the TLVs be divided by 10 before using them to evaluate IAQ exposures. Information regarding ASHRAE standards is available from ASHRAE, 1791 Tullie Circle, N.E., Atlanta, GA 30329.

- Many states are developing air toxics regulations or guidelines. Most of these states are applying safety factors to workplace exposure limits to develop ambient (outdoor) exposure limits. The safety factors used vary from state to state and range in magnitude from 42 to 100. These limits are designed to protect the more susceptible members of the general population (asthmatics, etc.) and, therefore, may be more applicable for evaluating the indoor environment where protection of similar populations is desired. However, the scientific basis for the safety factor must be understood and matched with the toxic hazard presented by each chemical.

Control Methods

A number of control methods are available to reduce the likelihood that science laboratories will create IAQ problems. These measures include selecting and purchasing the safest materials and minimizing quantities that are to be used, storing materials properly, ensuring that appropriate ventilation systems are available, utilized, operated, and maintained, and training laboratory users (teachers, aides, students) about the hazards in the laboratory and in the proper use and disposal of materials. The Material Safety Data Sheet (MSDS) specific to each chemical is an excellent resource document that communicates the hazards of a substance and recommends appropriate handling and control techniques as well as the use of personal protective equipment. MSDS are available, by law, from the manufacturer of the product. An effective laboratory safety program is one that integrates all methods of control. Important aspects of each technique are discussed below.

A. Elimination and Volume Reduction

The best way to ensure that a certain material will not create a problem is to eliminate its use (and presence) in the laboratory. Before using or purchasing chemicals or chemical-containing equipment it is always prudent to evaluate the consequences of its improper use against its value as a teaching tool. Consideration should be given to identification and use of substitute materials that may offer reduced toxicity, reactivity, or flammability; or limiting the material’s use to a well controlled demonstration. As a general guideline, it would be prudent to substitute or limit the use of any material rated 3

or 4 for Health, Flammability, or Reactivity by the commonly used National Fire Protection Association hazard rating criteria.
Certain well known hazardous materials have been eliminated, or drastically limited, in many laboratories. The following information summarizes some of the techniques used.

Alcohol lamps—These should not be used in schools. Use hot plates with water bath to eliminate the toxicity and flammability hazards presented by the use of alcohol.

Asbestos—The interior linings of laboratory hoods and many older heating elements, hot plates, hair dryers, “centers” of wire gauze, and gloves for handling hot items contained asbestos. Replace with non-asbestos insulated equipment.

Ether—Typical use has been for killing fruit flies in genetics experiments. Non-toxic methods for controlling the flies include refrigeration and placing flies on a Petri dish over ice for observation.

Formaldehyde—This substance was used historically for preserving and storing biological specimens. Schools should no longer purchase formaldehyde-based preservatives. Non-formaldehyde preservatives are readily available and have been found to be effective. Most of these alternatives contain ethylene glycol as a major ingredient.

Mercury—This very toxic material may become a hazard if mercury is spilled from a storage container, a barometer, or a broken mercury-filled thermometer. Metal or “spirit-filled” (hexane) thermometers should be substituted. If mercury thermometers must be used for high accuracy, purchase Teflon® coated instruments that will help contain the mercury if broken. Consider carefully the need for a mercury barometer and stored mercury. If used, a layer of water or mineral oil on top of a pool of mercury (barometer, storage bottle) will prevent mercury vapors from being given off.

Pathogenic organisms—These may be unintentionally cultured from the environment. Use only nonpathogenic organisms in the classroom for microbiology experiments. Treat all cultures as if they were pathogenic.

Pesticides—If their use is deemed necessary, always identify and use the least toxic material. Read and follow all instructions provided.

Table 1 presents some additional materials that have been substituted for toxic chemicals in certain experiments or for cleaning.

A technique that offers many benefits is microscale chemistry. It has been defined as a way of carrying out chemical experiments by using sharply reduced amounts of chemicals. Many experiments use as little as one one-thousandth (1/1000) of the traditional amount of chemicals. In addition to greatly reducing the amount of material that may become airborne, lab waste is reduced, the time required to perform the experiment is reduced, clean-up is easier, and less space is required. Microscale laboratory equipment and manuals are available through some supply houses. The National Microscale Chemistry Center at Merrimack College, 315 Turnpike St., North Andover, MA 01845 is promoting this technology through workshops and demonstration projects.

Table 1. Examples of Reduced Toxicity Through Substitution

Toxic Chemicals	Less Toxic Substitutes
Chloroform…………………………….	1,1,1 – Trichloroethane
Carbon Tetrachloride ………………..	Tetrachloroethylene
1,4 – Dioxane …………………………	Tetrahydrofuran or 1,2 – Dimethoxyethane
Benzene ………………………………	Cyclohexane or Toluene
2 – Butanol ……………………………	n-Butyl alcohol
p – Dichlorobenzene …………………	Napthalene
Dichromate/Sulfuric acid mixture ……	Ordinary detergent
Alcohol potassium hydroxide ………..	Ordinary detergent

B. Ventilation Requirements and Design

Room Ventilation

ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality, recommends 20 cubic feet per minute (cfm) of outdoor air per person for general dilution ventilation of laboratories on the premise of some odor generation. ASHRAE recommends that toxic or otherwise objectionable emissions are contained at the point of generation, as inside a laboratory hood, and exhausted outdoors.

As a general guideline, it is recommended that chemicals with an industrial exposure limit (i.e., OSHA Permissible Exposure Limit or ACGIH TLV) of 100 parts per million (ppm) or less (gas or vapor) or 0.1 mg/m^3 (solid) be handled inside a laboratory hood. Product MSDS may also stipulate use of local exhaust.

To avoid the spread of odors into other school spaces, the laboratory should be kept under negative pressure when in active use. Also, air from the laboratory should not be recirculated through a central air conditioning system supplying other areas. Negative pressure is best maintained by exhausting more air from a room than is mechanically supplied. How this is accomplished depends on the characteristics of the air conditioning system.

- Unit ventilators operating in a “free-cooling” mode introduce a variable rate of outdoor air up to the full circulation rate of their fans.

- A variable air volume system delivers a variable supply of air to the lab in response to the space thermostat.

- Lab exhaust air flow could also be variable depending upon laboratory hood fan operation.

To ensure this air imbalance, the supply and exhaust air flows must be compared under the full range of operating conditions. Typically, an inward flow from surrounding spaces into the lab to make up 10 to 15% of the air exhausted is sufficient. Since the corridor door should be kept closed whenever there is risk of offensive emissions, transfer grilles or ducts sized for a velocity of 100 feet per minute (fpm) can supplement leakage around doors to facilitate inward air flow from adjacent space. This imbalance is only necessary when lab activities require it. Since a positive pressure may occur when the laboratory exhaust fan is off, it should operate as long as inward flow of air into the room is necessary. Fire protection regulations in most jurisdictions do not permit transfer of air from a corridor through an unprotected opening such as a floor or wall grille. In these cases it may be necessary to transfer the make-up air through duct work from spaces not used as a means of egress.

Laboratory Hoods

A wide range of laboratory hood types are available, including variable air, volume, auxiliary air, and horizontal sash. However, for most school requirements a vertical sash, air foil, bypass type hood will be the preferred choice. Air foil design minimizes eddy currents at the sash opening and the bypass feature assures a constant exhaust volume and controls face velocities through the range of sash positions (See Figure 1).

Continuous operation of the laboratory hood, when not in use, can be costly if outdoor make-up air must be heated and cooled. For this and other sound reasons laboratory hoods should not be used to store materials requiring continuous exhaust.

Based upon recommendations of the American National Standards Institute and the American Industrial Hygiene Association (ANSI/AIHA Standard Z95-1992), a face velocity of 80 fpm should effectively remove fumes produced within the hood. This rate is based upon the full open sash position and is conditional upon proper use. It is also conditional upon:

(1) a room air supply system that does not create air velocities near the hood face greater than 50 fpm, and
(2) the hood being located away from foot traffic that could cause air turbulence and fume spillage from the hood.

Location near the room entrance should be avoided to prevent disturbing air flow and to avert a possible fire hazard in the path of egress. If the hood is dedicated for nonhazardous use, a low face velocity (60 fpm minimum) may be acceptable.

Laboratory Hood Exhaust Systems

Each laboratory hood should be exhausted by an independent system for simple, safe and flexible operation.

Corrosion resistant (e.g., plastic protected steel) centrifugal fans, with outboard bearings, should be located on or immediately below the roof to keep the duct within the building under negative pressure to prevent outward leakage. Either direct or belt driven fans can be utilized. Direct drive fans avoid degradation of performance due to drive belt slippage or breakage, but do not offer the flexibility of increased capacity should design estimates of air flow resistance fall short. Belt drives should have two or more belts rated at 200% capacity. Regardless of drive type, a corrosion resistant volume damper with tamper proof adjustment should be installed for each hood.

A variety of corrosion resistant duct materials are suitable, but most popular are Type 316 stainless steel and glass fiber reinforced polyester. Ducts within the building must be sealed against both inward and outward leakage. The duct run should be short and direct, sized for approximately 2000 fpm. Assuming objectionable materials will be conveyed by the laboratory hood exhaust system, the discharge arrangement must minimize entrainment into air intakes or open windows and contact with maintenance personnel or others on the roof.

Details of self draining discharge stacks and location guidelines can be found in the Industrial Ventilation manual (American Conference of Governmental Industrial Hygienists, Technical Information Office, 1330 Kemper Meadow Drive, Cincinnati, OH 45240). Specific design considerations include:

- Upblast vertical discharge
- No rain caps or screens
- Height of discharge above grade: 1.3 to 2 times height of the building but not less than 7 feet above highest roof or roof top air conditioning units
- Locate exhausts 25 feet or more from intakes.

Other Exhaust Locations

- Bench
  Air can be exhausted through slots into a duct located at the back of the lab bench to capture non-toxic fumes generated by students' activities. Although uncommon in schools, this could be a desirable feature in new or remodeled facilities.

- Storage Cabinet
  Some local jurisdictions require bottom venting of flammable liquid storage cabinets. While this is not required by NFPA 30, "Flammable and Combustible Liquids Code," some manufacturers provide plugged vent connections to accommodate these local requirements.

- Storage Room
  Usually located adjacent to the science labs, this space should be ventilated by exhaust at least at the rate recommended for laboratory space (approximately four air changes per hour). Preferably, ventilation is continuous, but could be discontinued when the room is secured and not in use. See NFPA Standard 30 for specific requirements for flammable and combustible liquids.

- Preparation Room
  This space is sometimes combined with storage and may contain a laboratory hood. See NFPA Standard 30.

- General Lab Exhaust
  To supplement laboratory hood and bench exhaust (or in their absence), general room exhaust may be necessary to assure the desired negative air pressure imbalance. The point of exhaust should be remote from the entrance door and other air sources. If practical, general movement of air should be away from occupants and across work surfaces. Several labs and storage rooms may be connected to a common system. Conventional duct construction is adequate.

C. Maintenance and Operation for Proper Ventilation

Laboratory Air Negative Pressure

By design, the laboratory should be maintained under slightly negative pressure whenever production of contaminants, undesirable odors, or fumes might occur. Laboratory hood fan operation may be needed to create this negative condition. Inward flow of air is observable at the crackage around the doors to transfer grilles by means of artificial smoke (as described below under qualitative testing of laboratory hoods). Check monthly for new installations, since the negative pressure is affected by the air conditioning system control and outdoor weather changes. Smoke testing can also reveal construction faults, especially above ceilings or other concealed penetrations, through which contaminants and odors could pass.

After the first year of operation, semiannual checks—and on complaint occasions—should suffice. Windows and exterior doors should not be operated in the labs except to air out after accidental spills and then only with precautions to prevent odor passage outward through doorways, transfer grilles or other apertures to occupied spaces.

Laboratory Hood Performance

Elements of the exhaust system, fan, motor fan drive, and discharge stack drain duct work (where accessible) should be inspected semiannually. Overheating of the duct could cause sealant loss or distortion resulting in excessive leakage and reduced hood effectiveness. Volume damper positions should be checked to verify no unauthorized adjustments have occurred. Worn belts should be replaced as a set, not individually.

The performance of the hood should also be verified on a regular basis, semiannually or as directed. Inspect the hood to assure the sash is in good operating condition, internal damage has not occurred, refuse in not restricting air paths, internal baffles are in originally adjusted position (which should be marked), and that it is not being used for material storage. Pilot lights, if provided to indicate fan operation, should be checked.

There are two approaches to testing laboratory hood performance. Quantitative testing, as detailed in ASHRAE Standard 110-1985, is costly and rarely would be appropriate for school applications. Qualitative testing to determine face velocities and air spillage is appropriate. Test equipment includes a calibrated velometer (a hot wire thermal anemometer preferably), smoke sticks (glass tubes containing artificial smoke producing chemicals) or a smoke powder gun (a most useful diagnostic tool for many HVAC investigations including negative pressure verification), and a supply of 30 second smoke bombs. This testing procedure is described in an inexpensive user guide (Saunders, G J, "Laboratory Fume Hoods, A User's Manual," 1993, John Wiley & Sons, NY). See also the American National Standard for Laboratory Ventilation (ANSI/AIHA Z95-1992) published by the American Industrial Hygiene Association, 2700 Prosperity Avenue, Suite 250, Fairfax, VA 22031.

Should this procedure be beyond the capability of school districts, it can be performed by qualified air balance or industrial hygiene firms. Such testing should occur prior to initial use and on a regular basis or whenever degradation of performance is suspected.

The need for testing may be reduced by use of a simple manometer or diaphragm actuated dial gauge to measure the pressure in the duct downstream of the hood. The device could be permanently mounted on the hood with the initial pressure marked after the initial hood commissioning. Pressure change will advise the user of any malfunction or degradation in face velocity. Monitors are also available with alarms that provide audible warnings that the exhaust system is performing below the set criteria. If a permanently mounted pressure indicator is deemed impractical due to concern over tampering, the maintenance or teaching staff could remove and reinstall the instrument with relative ease for periodic checking.

D. Storage

The importance of proper chemical storage must not be overlooked. The low levels of routine emissions expected in chemical storage areas are easily controlled with proper ventilation (see above). A well designed storage system can also minimize the potential for larger releases.

The first consideration for proper storage is one of inventory management. This step is a **must**. Computerized inventory management programs are available. The inventory should include the chemical name and the estimated amount in the container. Each chemical container should be checked periodically for rust, corrosion, and leakage and have the following information written on the container.

- Date of receipt
- Date of opening
- Date of scheduled disposal (if appropriate)

An up-to-date inventory can ensure that only needed purchases are made and that chemicals will not be stockpiled needlessly. It is important to consider storage limitations when placing orders for chemicals. Common practice in many school systems is to place one large order for the entire year's supply or chemicals. This practice leads to improper storage upon arrival because storage areas are quickly overwhelmed. To control this problem, smaller orders should be placed throughout the school year.

Next, the storage area should be organized so that only "compatible" chemicals are stored together, and that acids and flammables each have their own dedicated storage cabinets, Incompatible chemicals are those that, upon mixing, can react to produce explosions, fires, or large amounts of heat. It is also important to consider design and construction materials used for shelves and cabinets to minimize safety concerns (incompatibles, fire ratings, strength, spill containment).

A recommended storage pattern is to divide and separate the inventory into the eighteen groups of compatible chemicals presented in ***Figure 2*** and ***Figure 3*** below. The basic philosophy to follow is that every chemical should have a definite storage place and should be returned to that place after each use.

There are a number of other storage practices that are either required by regulations or generally accepted as prudent practice. For example, the National Fire Protection Association publishes standards for the storage and handling of flammable liquids, the Nuclear Regulatory Commission regulates the use of radioactive materials, and various trade and professional organizations have developed guidance that has become standard in the area of laboratory health and safety. A resource book that provides an excellent overview of this subject is the National Research Council's "Prudent Practices for Handling Hazardous Chemicals in Laboratories" (National Academy Press, Washington DC, 1981).

Figure 2. Compatible Inorganic Groups	Figure 3. Compatible Organic Groups
1. Metals, Hydrides (store flammable solids in flammables cabinet) 2. Acetates, Halides, Iodides, Sulfates, Sulfites, Thiosulfates, Phosphates, Halogens 3. Amides, Nitrates (except ammonium nitrate), Nitrites, Azides (ammonium nitrate is separated and stored by itself) 4. Hydroxides, Oxides, Silicates, Carbonates, Carbon 5. Sulfides, Selenides, Phosphatides, Carbides, Nitrides 6. Bromates, Chlorates, Perchlorates, Perchloric Acid, Chlorites, Hypochlorites, Peroxides, Hydrogen Peroxide 7. Arsenates, Cyanides, Cyanates 8. Borates, Chromates, Manganates, Permanganates 9. Acids *(except Nitric) (Nitric Acid is isolated and stored by itself) 10. Sulfur, Phosphorus, Arsenic, Phosphorus Pentoxide * Store acids in approved acid cabinet	1. Acids *(except acetic and formic),** Anhydrides, Peracids 2. Alcohols, Glycols, Amines, Amides, Imines, Imides*** 3. Hydrocarbons, Esters, Aldehydes*** 4. Ethers, Ketones, Ketenes, Halogenated Hydrocarbons, Ethylene Oxide*** 5. Epoxy Compounds, Isocyanates 6. Peroxides, Hydroperoxides, Azides 7. Sulfides, Polysulfides, Sulfoxides, Nitriles 8. Phenols, Cresols * Store acids in approved acid cabinet ** Acetic acid is separated and stored by itself, formic acid is stored in flammables cabinet *** Store flammables in approved flammables cabinet

(Permission to include this information was obtained from Flinn Scientific, Inc., P.O. Box 219, Batavia IL 60510. Phone: 1-800-452-1261; Fax: 630-879-6962.)

E. Disposal

Laboratory waste accumulation and disposal can also present IAQ concerns. Each school should have a procedure for collecting wastes and arranging for their disposal. First, each school should ensure that they fall under the "conditionally-exempt small quantity generator" status accorded by the Resource Conservation and Recovery Act (RCRA; 40 CFR, Parts 260-266). This status is for those generating less than 100kg/month of hazardous waste. Exempt sites may accumulate hazardous waste indefinitely by law; however, prudent practice dictates that the quantities of waste generated and stored should be minimized.

Great care must be taken for disposal of chemicals to the sewer system (i.e., "down the drain"). Environmental damage and upset of the sewage treatment processes can result. Local wastewater discharge regulations should be reviewed to ensure that disposal restrictions are not violated. In general, the following guidance should be followed for disposal via laboratory drains:

- Only water-soluble materials of low toxicity may be disposed of through the laboratory drain.
- Acid and base solutions with a pH range of 3 – 11 may be disposed of through the laboratory drain if poured slowly.

Highly toxic, flammable, or malodorous chemical should not be disposed of down the drain. Drains are typically interconnected; a substance that goes down one sink may come up as a vapor in another. There is also a potential hazard of chemicals from two sources contacting one another. Some simple reactions can cause explosions or create extremely noxious vapors.

In the biology laboratory, sterile plastic Petri dishes should be used only once. Following their use, the dishes should be taped shut, bagged, and properly disposed. Glass Petri dishes must be sterilized before using. Following use, they can be soaked in strong disinfectant and washed. Alternately, they can be autoclaved, the culture medium disposed in a sealed container, and the dishes then washed in detergent. Likewise, specimens should be carefully bagged and properly disposed. These wastes will not ordinarily be considered infectious or medical wastes which require special disposal.

F. Chemical Hygiene Plan

A laboratory Chemical Hygiene Plan (CHP), such as that required under the Occupational Safety and Health Act (OSHA, 29 CFR 1910.1540), can maintain good IAQ through a comprehensive program of work practices, procedures, and policies.

The CHP includes the following elements:

- Standard operating procedures (SOPs) relevant to ensuring safety and health;
- Methods to reduce exposures through use of engineering controls (hoods, etc.), personal protective equipment (gloves, aprons, goggles, etc.), and good hygiene practices, (hand washing, no food in lab, etc.);
- Measures taken to ensure laboratory hoods are functioning properly;
- Information (CHP, MSDS, other references) and training on the hazards present and ways to protect one's self (including emergency plans). Most of the requirements of this element are also required under OSHAs Hazard Communication Standard (29 CFR 1910.1200);
- Laboratory activities requiring prior approval;
- Procedures for medical consultation and examination;
- Personnel responsible for implementing the CHP
- Policy incorporating higher levels of protection for work involving carcinogens, reproductive toxins, and chemicals with high acute toxicity.

Specific requirements for a CHP vary from one locality to another. In Maryland, for example, the employees of public school systems are covered by the regulations administered and enforced by Maryland Occupational Safety and Health (MOSH) which require CHPs; in addition to paralleling most other OSHA requirements. Consult with health and safety support staff or regulatory offices in your area.

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The subject of indoor air quality and laboratory facilities is quite complex and necessarily crosses over into the even broader or more complex issues of laboratory health and safety. The following references are provided for those who may which to examine certain issues in more depth:

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This bulletin was developed and published in part, with funds from the U.S. Environmental Protection Agency, Indoor Air Division.

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