

Pennsylvania Department of Health
Indoor Air Quality Guidelines for Pennsylvania Schools
May 2002

PREFACE

This document provides useful information on indoor air quality (IAQ) in schools to school officials and others who have an interest in this topic. It offers practical guidance that will help prevent IAQ problems in schools, and resolve or alleviate such problems if they do arise. It is particularly designed to assist those officials who have the primary responsibility of providing a safe and healthy environment for students, teachers, and the general school community. This easy-to-use guidance document describes how to implement a practical plan of action using a minimal amount of resources. The document includes general guidelines to prevent or help resolve IAQ problems, additional guidelines on specific indoor contaminants, recommendations on IAQ management approaches, recommendations on seeking professional assistance, and selected resources and references. School Officials are encouraged to review and proactively use the information in this document. Many IAQ problems can be resolved with preventative maintenance approaches as described.

Bureau of Epidemiology
May 2002

INDOOR AIR QUALITY GUIDELINES FOR PENNSYLVANIA SCHOOLS

This document is designed to provide practical guidance that will help prevent indoor air quality (IAQ) problems in schools and resolve such problems quickly if they do arise. Recommendations for reasonable steps that can be taken by the school staff are offered with an eye toward flexibility for the specific needs of your school. The information in the document has been derived from the Environmental Protection Agency's (EPA's) report, Indoor Air Quality Tools for Schools, other published documents, and our experience in this area.

WHY IAQ IS IMPORTANT TO YOUR SCHOOL

Most people are aware that outdoor air pollution can damage their health but many do not know that indoor air pollution can also have significant health effects. EPA studies of human exposure to air pollutants indicate that indoor levels of pollutants may be 2-5 times, and occasionally 100 times, higher than outdoor levels. These levels of indoor air pollutants are of particular concern since most people spend the majority of their time indoors. Good indoor air quality in schools is an important component of a healthy indoor environment. It contributes to a favorable learning environment for students, productivity for teachers and staff, and a sense of comfort, health, and well-being. These elements combine to assist a school in its core mission -- educating children.

The definition of good indoor air quality management includes control of airborne pollutants, introduction and distribution of adequate outdoor air, and maintenance of acceptable temperature and relative humidity. Temperature and humidity are important because thermal comfort concerns underlie many complaints about "poor air quality." Temperature and humidity can also affect indoor contaminant levels. Failure to respond quickly and effectively to IAQ problems can lead to numerous adverse health, cost, and educational process consequences.

Children may be especially susceptible to air pollution. The same concentration of pollutants can result in higher body burden in children than adults because children breathe a greater volume of air relative to their body weight.

Unlike other buildings, there are many unique aspects of schools. The occupants of schools are close together, with the typical school having about four times as many occupants as office buildings for the same amount of floor space. A variety of potential pollutant sources exist in schools, including art and science materials, industrial and vocational arts, and gymnasiums. In combination with natural ventilation, schools may use many heating, ventilating, and air conditioning systems (HVAC), including unit ventilators and rooftop units. All require appropriate care and maintenance.

TYPICAL IAQ PROBLEMS IN SCHOOLS

Indoor air contaminants can originate within the school building or be drawn in from the outdoors. If pollutant sources are not controlled, indoor air problems can develop even if the HVAC system is properly designed, operated, and maintained. Air contaminants consist of particles, dust, fibers, biological agents (e.g., bacteria, viruses, and mold), and

gases or vapors. Sources of indoor air contamination include polluted outdoor air and underground sources (e.g., radon, pesticides, and leakage from underground storage tanks). Indoor air contamination can also be caused by a variety of indoor sources (e.g., equipment, furnishings, and housekeeping supplies).

Indoor concentration levels of air pollutants can vary by time and location within the school building, or possibly a single classroom. Pollutants can be emitted from point sources, such as science storerooms, or from area sources, such as newly painted surfaces. Pollutants can vary with time, such as only when floor stripping is done, or continuously such as fungi growing in the HVAC system.

Indoor air often contains a variety of contaminants at concentrations that are well below any standards or guidelines for occupational exposure. It is often difficult to relate complaints of specific health effects to exposures to specific pollutant concentrations, especially since the exposures may be to low levels of pollutant mixtures.

GENERAL GUIDELINES TO PREVENT OR HELP RESOLVE IAQ PROBLEMS

To prevent or help resolve indoor air quality problems effectively and efficiently, schools must ensure that recommended temperature and relative humidity ranges be maintained in the indoor air and that the HVAC system is working properly. In addition, monitoring for carbon dioxide (CO₂) may be useful for indicating when outdoor air ventilation may be inadequate. A properly designed and functioning HVAC system controls temperature and relative humidity levels to provide thermal comfort, distributes adequate amounts of outdoor air to meet the ventilation needs of school occupants, and isolates and removes odors and other contaminants through pressure control, filtration, and exhaust fans. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 55-1992 describe the temperature and humidity ranges that are comfortable for most people. Generally, temperature and humidity should be maintained within the comfort zone of 68 to 78 degrees and 30% to 60% relative humidity, depending on the season.

ASHRAE's Standard 62-1989 should be followed for recommended outdoor air ventilation levels in schools. These levels are described in EPA's report, Indoor Air Quality Tools for Schools. Generally, a range of 15 to 60 cubic feet per minute of outdoor air for each person in the area served by the HVAC system is recommended.

Additionally, CO₂ can be used as a rough indicator of the effectiveness of ventilation. CO₂ levels above 700 parts per million (ppm) above background levels indicate inadequate ventilation with outdoor air.

Finally, good housekeeping practices and common sense approaches used in the routine maintenance and upkeep of the school help to protect the quality of the indoor environment and the health and well being of school occupants. There are six basic control methods for lowering concentrations of indoor air pollutants in school buildings:

Source Management

Source Management includes source removal, source substitution, and source encapsulation. It is the most effective control method when it can be practically applied. The best prevention method is never to bring unnecessary pollutants into the school building.

Local Exhaust

Local Exhaust is very effective in removing point sources of pollutants before they can be dispersed into the indoor air by exhausting the contaminated air outside. Examples where local exhaust is used include restrooms, kitchens, science labs and housekeeping storage rooms, printing and duplicating rooms, and vocational/industrial areas such as welding booths.

Ventilation

The ventilation system, when properly designed, operated, and maintained, will automatically take care of normal amounts of air pollutants. For certain situations, such as painting, temporarily increasing the ventilation can help dilute the concentration of fumes in the air.

Exposure control

Exposure control includes adjusting the time, amount, and location of use to reduce potential exposures.

Air cleaning

This primarily involves the filtration of particles from the air as the air passes through the HVAC equipment.

Education

Education of the school occupants regarding IAQ is critical. If people are provided information about the sources and effects of pollutants under their control, and about the proper operation of the ventilation system, they can act to reduce their personal exposure.

School officials should appoint an IAQ Coordinator who will serve as the primary school contact for problem solving and problem prevention. The role and functions of an IAQ Coordinator are described in Section 3 of EPA's report, Indoor Air Quality Tools for Schools. In larger school districts, the IAQ Coordinator may be a district level administrative person, such as the business official, a health and safety officer, or the facilities manager. In smaller school systems, the IAQ Coordinator may be the Principal or Vice Principal at individual schools.

ADDITIONAL GUIDELINES ON SPECIFIC INDOOR CONTAMINANTS

EPA's report, Indoor Air Quality Tools for Schools (page 51), has a listing of typical indoor air contaminants in schools. The listing also contains a description of the contaminant, its sources, standards and guidelines, health effects, and measurement and control methods. The purpose of this section is to provide additional guidelines for

schools on some of these specific indoor contaminants. Familiarization with this section should be considered for all school staff.

Carbon monoxide (CO)

CO is a colorless, odorless, and tasteless gas. It results from incomplete oxidation of carbon in combustion. Adverse health effects from CO (an asphyxia gas) are due to the formation of carboxyhemoglobin in the blood, which inhibits oxygen uptake. CO is unique among air pollutants in that the degree of body burden from exposure to this gas can be directly determined by measuring the percent of carboxyhemoglobin in the blood. Normal carboxyhemoglobin concentrations are <2% for nonsmokers and 5%-9% for smokers. At moderate concentrations, early symptoms may be nonspecific (e.g., headache, dizziness, weakness, nausea, visual disturbances, and confusion). At higher concentrations, CO exposure may be fatal. Adequate ventilation is an important control measure.

No standards for CO have been agreed upon for indoor air. EPA's national ambient air quality standards for outdoor air are 9 ppm for eight hours and 35 ppm for one hour. These standards can be used as guidelines for indoor air in schools and should not be exceeded. Monitoring and control measures (e.g., ventilation with outdoor air) are recommended whenever these guidelines are exceeded. It is also important to determine the source(s) of elevated CO levels and correct all identified problem areas.

Carbon dioxide (CO₂)

CO₂ is a colorless, odorless, and tasteless gas. It is a product of completed carbon combustion. Adverse health effects from CO₂ may occur since it is an asphyxia gas, which essentially displaces oxygen in the air. At concentrations above 15,000 ppm, some loss of mental acuity has been noted.

ASHRAE's current standard recommends that CO₂ levels be maintained below 700 ppm above background levels. The ASHRAE standard can be used as a guideline for schools and should not be exceeded. Monitoring and control measures (e.g., ventilation with outdoor air) are recommended whenever the guideline is exceeded.

Pesticides

Pesticides are chemicals that are used to kill or control pests, which include bacteria, fungi, weeds, and other organisms, in addition to insects and rodents. Most pesticides are inherently toxic. Most contain volatile organic compounds. The specific symptoms that may result from a given pesticide exposure situation depend on the pesticide and its site of action, the dose received, and the sensitivity of the exposed individual(s). Chronic exposure to some pesticides can result in damage to the liver, kidneys, and nervous system.

There are no indoor air concentration standards for pesticides. Both EPA and the Pennsylvania Department of Agriculture recommend Integrated Pest Management in schools, an approach that minimizes the use of chemical pesticides. Pesticide products

should be used according to application and ventilation instructions provided by the manufacturer.

Radon

Radon is a colorless, odorless, and tasteless radioactive gas. The unit of measure for radon is picocuries per liter (pCi/L). The earth around buildings is the principal source of indoor radon. Radon penetrates crack and drain openings in foundations, basements, and crawl spaces. Water containing radon will release radon into the air when drawn for use indoors. Some building materials will also release radon into the air. Exposure to radon may cause lung cancer in humans.

EPA recommends taking actions to mitigate radon if levels exceed four pCi/L. Active soil depressurization and building ventilation are the two most commonly used strategies for controlling radon in schools.

Mercury

In recent years, increasing numbers of metallic mercury spills and contamination involving school children have been reported. Mercury occurs naturally in the environment in several forms. Metallic mercury is the liquid form used in a variety of consumer products, including thermometers and barometers. It may also be found in school laboratories and accidental spills in the past have caused contamination problems. Metallic mercury vaporizes into the air at room temperatures. Small amounts of mercury (e.g., a few drops) can raise air concentrations to levels that may be harmful to health. Mercury vapor is denser than air and settles on or near the floor. Because of this effect, children may be exposed to higher concentrations of mercury than adults. Mercury affects the central and peripheral nervous systems and the kidneys.

To test for air contamination, a level of 0.003 milligrams of mercury per cubic meter of air (mg/m³) can initially be used as an “action” level for “screening” purposes in either homes or public places such as schools. This level is the most practical level since initial screening is usually performed with the Jerome meter, which only has a detection level of about 0.003 mg/m³. The decision to recommend temporary evacuation or any other action steps should be made on a case-by-case basis, depending on the circumstances. The actual mercury levels in the air should be determined by appropriate follow-up air sampling using more reliable testing methodology than the Jerome meter over an extended period of time. Based on such follow-up testing, levels of mercury which exceed 0.001 mg/m³ would be considered unacceptable. The level 0.001 mg/m³ is a health guidance value which is based on occupancy at a school (or a public place) not exceeding 40 hours per week. This value was derived based on EPA’s lifetime health guidance value of 0.0003 mg/m³ for residential sites.

Biological Agents

People, animals, and environmental conditions produce biological materials which include bacteria, mold, and pollen. When airborne, these agents usually attach to dust particles of various sizes. Drapery, carpet, and other places where dust can collect harbor these agents. Dirty cooling coils, humidifiers, condensate drains, and ductwork can incubate bacteria and molds. Areas with high humidity can accelerate their growth.

Various types of infections such as influenza are transmitted by air. Pollens and molds may cause allergic reactions, such as asthmatic episodes, for many individuals. No standards exist for biological agents in indoor air, although ASHRAE recommends relative humidity levels between 30 and 60 percent to control growth. Other control measures include general good housekeeping and proper maintenance of HVAC equipment. Adequate ventilation and good air distribution are also helpful. The National Institute for Occupational Safety and Health (NIOSH) generally does not routinely recommend air sampling. Visible microbial growth on interior building surfaces and signs of water leaks found during a thorough inspection for possible moisture sources in the school are indications of a potential biological problem. Based on these findings, steps should be taken to correct conditions supporting such problems. If sampling is conducted, it should be done in both the problem area and other areas of the school. Differences in biological agents present in the problem area compared to other areas of the school can help to determine the extent of contamination and the appropriate approaches for remediation.

Volatile Organic Compounds (VOCs)

There are hundreds of VOCs found in indoor air, sometimes in concentrations that are suspected of being harmful. More commonly known VOCs include benzene, formaldehyde, methylene chloride, trichloroethylene, and tetrachloroethylene. Exposure to VOCs can result in both acute and chronic health effects, depending on many factors such as the level of exposure and the length of exposure. A few VOCs have been directly linked to cancer in humans (e.g., benzene), and others are suspected of causing cancer.

No standards have been set for VOCs in non-industrial settings. In industrial settings, NIOSH has recommended occupational standards for many compounds. These NIOSH recommendations and other health guidelines and standards may be useful in determining if VOC levels measured in schools are acceptable. Where practical, uses of known sources of VOCs should be restricted. These materials should be stored in properly sealed containers and in well-ventilated areas, apart from occupied zones.

In the past, the Department of Health has provided guidance in residential and school situations involving underground fuel or gasoline spills. These spills increased indoor air levels of hydrocarbons. Recommendations for temporary evacuation are made if total hydrocarbon levels were 10 ppm or higher, or benzene levels were 100 parts per billion (ppb) or higher. At lower levels, corrective actions should be implemented to address the problem, including forced ventilation. The goal is to reduce the levels to normal background levels. The Occupational Safety and Health Administration (OSHA) has set a legal limit of 500 ppm of petroleum distillates and one ppm of benzene in air in the workplace.

Lead

Lead is a highly toxic metal. Exposure to lead can come from a variety of sources, including contaminated soil and dust, and air. Lead-based paint is the most common source of lead exposure to children. Lead can cause damage to the brain, kidneys, nervous system, and red blood cells. Children are especially vulnerable to lead exposure, since lead is more easily absorbed into growing bodies, and the tissues of small children

are sensitive to its effects. Exposure to lead is estimated by measuring lead levels in the blood.

Preventive measures to reduce lead exposure in schools include keeping children away from areas where paint is chipped or peeling and assuring that children are protected from contaminated air during any lead abatement projects in schools. Currently, there are no indoor air standards for lead in schools. Existing standards for lead are for outdoor air or industrial workplaces.

ADDITIONAL RECOMMENDATIONS ON IAQ MANAGEMENT APPROACHES

School officials are encouraged to develop and implement their own IAQ Management Plan in order to address, prevent, and resolve IAQ problems in their specific schools. EPA's report, *Indoor Air Quality Tools for Schools*, provides a set of flexible and specific activities which should be useful to school officials in developing such a plan. A key feature of the plan is the selection of an IAQ Coordinator. Other critical features of the plan include establishing necessary IAQ Policies, Assessing the Current Status of indoor air quality in the school through periodic inspections and maintaining appropriate logs and checklists, Performing Necessary Repairs and Upgrades, and Implementing Final Follow-up Assessments and Steps. Because of the complexities involved in setting priorities for repairs and upgrades, and for committing school resources, it is important to maintain good communication to build consensus involving school management and all appropriate committees and groups. In dealing with indoor air problems, an important management approach is to foster a team approach for problem solving and consensus building. The IAQ Team should include, but not necessarily be limited to, teachers, administrative staff, facility operators, custodians, school nurses, school boards, contract service providers, and parents and students.

RECOMMENDATIONS ON SEEKING PROFESSIONAL ASSISTANCE

Many indoor air problems can be resolved when school personnel follow good housekeeping approaches, such as described earlier under guidelines. Many potential problems can be prevented if students and staff cooperate to maintain good indoor air quality in the school. Some problems may be difficult to resolve, however, and may require outside assistance. Local, State or Federal governmental agencies (e.g., Education, Health, Environmental Protection, or Agriculture Agencies) may be able to provide expert assistance or direction in solving IAQ problems. If available governmental agencies do not have personnel with the appropriate skills to assist in solving your IAQ problem, they may be able to direct you to private firms or consultants in your area with experience in indoor air quality work. Some of these firms may be found in the yellow pages (e.g., under "Engineers," "Environmental and Ecological Services," "Laboratories-Testing," or "Industrial Hygiene Consultants") or by asking other schools for referrals. The skills of HVAC engineers and industrial hygienists are very useful for investigations of serious IAQ problems. Some professionals who work with IAQ problems (e.g., engineers, industrial hygienists) have licensing and certification requirements to practice in their disciplines. Input from other disciplines may also be important, depending on the nature of the problem.

SELECTED RESOURCES

This section lists organizations with information or services related to indoor air quality. In addition, publications or information available on the Internet are also provided.

Pennsylvania State Government

Your questions and concerns about indoor air problems in schools can frequently be answered best by commonwealth agencies. Possible contacts with the Commonwealth of Pennsylvania are the following:

Pennsylvania Department of Health Bureau of Community Health Services 717-787-4366

District offices and county/municipal health departments serving specific areas of the state (See attached list)

Pennsylvania Department of Health Division of School Health 717-787-2390

Pennsylvania Department of Health Bureau of Epidemiology Division of Environmental Health Assessment 717-787-1708 or 717-783-4677

(Health consultation on environmental health issues and public policy issues)

Pennsylvania Department of Environmental Protection, Field Operations 717-787-5028 (Regional offices serving specific areas of the state – See attached list)

Pennsylvania Department of Environmental Protection Bureau of Air Quality Control 717-787-9702 (Air quality control issues and problems)

Pennsylvania Department of Agriculture Division of Health and Safety 717-787-4843 (Integrated Pest Management in schools; pesticides; hypersensitivity registry)

U.S. Environmental Protection Agency (EPA)

EPA conducts a comprehensive non-regulatory indoor air quality program that emphasizes research, information dissemination, technical guidance, and training. EPA also issues regulations and carries out other activities that affect indoor air quality under the laws for pesticides, toxic substances, and drinking water.

Indoor Air Quality Information Clearinghouse

P.O. Box 37133 Washington, D.C. 20013-7133

Toll Free: 1-800-438-4318

(Information specialists are on duty Monday to Friday from 9:00 a.m. to 5:00 p.m. eastern time. The Clearinghouse provides indoor air quality information and publications.)

EPA's Internet Address for IAQ and Schools: <http://www.epa.gov/iaq/schools/>

Selected EPA's IAQ technical reports and publications:

- Indoor Air Quality Basics for Schools, October 1996 (fact sheet).
- Indoor Air Quality Tools for Schools Kit, 1995.
- Building Air Quality: A Guide for Building Owners and Facility Managers, 1991.

MidAtlantic Environmental Hygiene Resource Center

The MidAtlantic Environmental Hygiene Resource Center (MEHRC) was established to provide training in indoor environments, with particular focus on indoor air quality. The Center was established with support from EPA, Region III, the U.S. Public Health Service, Region III, and the University City Science Center. The Center is a non-profit program which aims to meet the diverse needs of those concerned with indoor environments through training in engineering, microbiological, health, legal and other issues, ranging from introductory to advanced technical levels.

MidAtlantic Environmental Hygiene Resource Center

University City Science Center

3624 Market Street, First Floor East

Philadelphia, PA 19104

215-387-4096

MEHRC's Internet Address: <http://www.mehrc.org>

National Institute for Occupational Safety and Health (NIOSH)

1-800-35-NIOSH

www.cdc.gov/niosh

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

1791 Tullie Circle, NE Atlanta, GA 30329

404-636-8400

www.ashrae.org

The Occupational Safety and Health Administration (OSHA)
OSHA Region III Office
215-596-1201
www.osha.gov

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DIVISION OF SCHOOL HEALTH
SCHOOL HEALTH CONSULTANTS
May 2002

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COUNTIES
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Lackawanna Pike
Lehigh Susquehanna
Luzerne Wayne
Monroe Wyoming

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Bucks Montgomery
Chester Philadelphia
Delaware Schuylkill

NORTHCENTRAL DISTRICT
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COUNTIES
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Centre Potter
Clinton Snyder
Columbia Sullivan
Lycoming Tioga
Montour Union

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COUNTIES
Adams Huntington
Bedford Juniata
Blair Lebanon
Cumberland Mifflin
Dauphin Perry
Franklin York
Fulton

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COUNTIES

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Clarion	Lawrence
Clearfield	McKean
Crawford	Mercer
Elk	Venango
Erie	Warren
Forest	

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COUNTIES

Allegheny	Greene
Armstrong	Indiana
Beaver	Somerset
Butler	Washington
Cambria	Westmoreland
Fayette	

**COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF
 ENVIRONMENTAL PROTECTION**

May 2002

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Chester	Philadelphia
Delaware	

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COUNTIES

Carbon	Montgomery
Lackawanna	Schuylkill
Lehigh	Susquehanna
Luzerne	Wayne
Monroe	Wyoming
Northampton	

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COUNTIES

Adams	Huntington
Bedford	Juniata
Berks	Lancaster
Blair	Lebanon
Cumberland	Mifflin
Dauphin	Perry
Franklin	York
Fulton	

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COUNTIES

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Centre	Potter
Clearfield	Snyder
Clinton	Sullivan
Columbia	Tioga
Lycoming	Union

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Cambria	Washington
Fayette	Westmoreland

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COUNTIES

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Clarion	Lawrence
Crawford	McKean
Elk	Mercer
Erie	Venango
Forrest	Warren

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May 2002

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Deputy Director for Personnel Services: Anita Criely, RN, BSC, MPH

Deputy Director for Environmental Health Services:

Anna Johnson-Entsua

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