MOLD IN MY SCHOOL: WHAT DO I DO?

JULY 2001

A COMMON SITUATION

When any building material or furnishing is damp for more than 48 hours, mold may grow. Many schools have experienced water damage in buildings due to roof or plumbing leaks, floods, and poor drainage of rainwater runoff or landscape irrigation. Damp buildings support mold growth and other biological contaminants that may cause health problems for some adults and children. This fact sheet provides information on the most important indoor mold-related health concerns and how school districts can keep school facilities mold-free and avoid these problems.

WHEN TO BE CONCERNED

Mold fragments and spores (the microscopic reproductive units of molds) are present everywhere on earth in air and dust, both indoors and outdoors. Mold grows in buildings if the indoor air is very damp or there have been water leaks. You may suspect that mold is present if you see visible growth or smell moldy odors. Exposure to mold may affect the health of both children and adults. The severity of the health effect depends on factors such as the amount and type of mold, how close the person is to areas of mold growth, how much time he or she spends in the building and the person's susceptibility. Indoor air quality experts agree that buildings with visible mold or moldy odors increase the risk of health problems. Molds should be removed from buildings promptly, using methods that protect the safety and health of both the occupants and the staff performing the clean up.

HOW MOLDS CAUSE HEALTH PROBLEMS

Molds usually cause adverse health effects when they are inhaled in large numbers. The number of mold fragments or spores needed to cause health problems is unknown and varies from person to person. Some people report no problems even in very moldy environments while persons who are allergic to molds may respond to very few spores. Besides inhalation, people are also exposed to mold through skin contact and food. Some molds also produce compounds called "toxins" or "mycotoxins." In high concentrations, these compounds may cause symptoms even in individuals who do not have allergies.

WHAT SYMPTOMS ARE CAUSED BY MOLD EXPOSURE?

Any or all of the following are symptoms that may be caused by mold allergies:

- nasal or sinus congestion
- sensitivity to light
- sneezing
- sore throat
- cough
- skin irritation (rash or itching)
- shortness of breath
- headache
- watery, reddened, or burning eyes
- fatigue

WHAT ABOUT INDOOR MOLDS THAT FORM TOXINS?

Many species of mold (including some that grow indoors) can produce chemicals that are toxic to other microorganisms. These compounds help molds compete in nature for food and other resources. Some of these toxins also affect people. Symptoms that have been attributed to mold toxin exposure include fatigue, nausea, diarrhea, headache, and eye, skin and respiratory irritation. Many of these

symptoms have been described in studies of moldy buildings, but a cause-and-effect relationship has not been proven. All of the reported symptoms are non-specific and can be caused by many other health conditions. Therefore, it is very difficult for physicians and researchers to determine whether specific symptoms are due to exposure to mold toxins.

Who is at Most Risk For Mold-related Health Problems?

Infants, toddlers, children, the elderly, those with compromised immune systems and people with existing respiratory conditions such as allergies or asthma may have a higher risk for health problems from elevated levels of mold spores. Damp buildings and mold growth are recognized triggers of asthma attacks.

Can Medical Tests Identify Mold Allergies?

Current tests can identify allergies to fewer than ten of the hundreds of molds that can grow indoors. Therefore, students or staff may have mold allergies that a doctor cannot accurately diagnose with an allergy test.

Is There a Test That Will Indicate Whether Students or Staff Have Been Exposed to Mold Toxins?

No, there are no blood, urine or other medical tests that can determine whether someone has been exposed to a mold toxin. Researchers and laboratories are working to develop such tests, but none has yet been shown to be accurate.

Is There a Test That Will Indicate Whether Students or Staff Have Been Exposed to Molds Inside School Buildings?

No. The allergy tests mentioned above may identify people who are hypersensitive to molds. However, there is no medical test that can accurately determine where or when people were most recently exposed to the molds that activate their allergies. People encounter high levels of airborne mold spores in many places, for example, when gardening, mowing lawns, playing outdoor sports, hiking or camping.

Is It Important to Determine if the Mold in My School is Toxic?

No. It is not necessary to know if toxins are present to take appropriate action and remove molds.

There are no readily available tests that can determine if a mold growing in a school building is producing toxins. Laboratory studies show that many molds have the ability to produce toxins but that they do not always do so. Whether a mold produces a toxin in a building may depend on the material on which it is growing, building conditions (such as temperature or humidity) and which other microorganisms are present.

What About Classrooms With Sick Children or Teachers But No Visible Mold?

Symptoms of mold exposure are similar to symptoms of many other illnesses, including colds, flu, and hay fever from pollen. Animal danders, from classroom pets or from classmates bringing in pet allergens on their clothing may also cause “school-related” symptoms. Nonenvironmental factors, such as headaches from low blood sugar or caffeine withdrawal may contribute to classroom symptoms. Teachers and children who feel ill at school should be encouraged to see their doctor for proper evaluation. Classroom occupants who react to poor indoor air quality are often ill when they are in school buildings but feel better when they are off campus. If so, facilities personnel should inspect these rooms for all sources of poor indoor air quality (of which hidden mold may be one). Other environmental sources of poor indoor air quality include:

- closed or blocked fresh-air intake vents
- clogged or missing ventilation system filters
- artwork covering room thermostats
- delivery trucks idling beside fresh air intakes

BASIC VOLUNTARY GUIDELINES FOR CLEANUP AND PREVENTION OF ALL MOLDS

WHEN SCHOOL BUILDINGS GET WET (DUE TO RAIN OR A CLEAN WATER SPILL)

DO

- Dry building materials and furnishings as rapidly as possible (within 48 hours to prevent the initiation of mold growth) by:
  - bringing in portable fans to increase air circulation and speed the drying process,
  - pulling up edges of wall-to-wall carpet to allow increased air circulation (if carpet is very dirty, old, damaged or cannot be dried within 48 hours, consider discarding it),
  - running fans continuously (24 hours/day) until materials are dry, and
  - if room has flooded to a depth of greater than 1 inch, removing base-boards and drilling holes through the bottom of the drywall to improve wall cavity drying.

DO NOT

- Close up the room and turn on the heater (this will only increase the likelihood of mold growth).

IF BUILDINGS ARE FLOODED BY DIRTY WATER OR SEWAGE

DO

- Contact professional consultants for appropriate cleaning and disinfection methods.

GETTING RID OF MOLD GROWTH INSIDE A SCHOOL BUILDING

DO

- Find the source of water intrusion, leakage or water vapor accumulation and correct it. If the moisture source is not eliminated, the mold **will grow back.**
- Remove mold appropriately. Disinfection alone (with bleach or other chemicals) is not recommended because it does not remove the potential source of health problems, the mold spores and fragments. California Department of Health Services staff recommends school facility personnel adopt the guidelines for mold cleanup and removal produced by the United States Environmental Protection Agency (U.S. E.P.A.) or the New York City Department of Health (available at their website, see Resources). These guidelines provide assistance in determining whether school maintenance personnel can safely remove or clean moldy materials or if specially trained individuals should be consulted. The recommendations in these two guidelines protect the health of building occupants regardless of the type of mold. When visible mold is present, an extensive, costly testing protocol is not required. Rather, schools can use their limited financial resources more effectively in identifying and correcting the water problem and remediating visible mold growth.

DO NOT

- Just paint over mold on walls, ceilings or floors — clean it off or remove it based on U.S. E.P.A. or New York City Department of Health guidelines.
- Attempt to clean or disinfect moldy wall-to-wall carpet. If it has a moldy odor or mold is visible on its top or bottom surface, it should be replaced.

PREVENTING MOLD GROWTH IN SCHOOLS

DO

- Rapidly respond to water leaks by fixing them or preventing water entry into buildings.
- Dry any wet building materials and furnishings within 48 hours, if possible.
- Ensure that mechanically ventilated rooms are run on continuous ventilation (rather than temperature demand control) when they are occupied.
- Establish a regular schedule for inspecting roofs, ceilings, walls, floors and carpeting for water leakage and mold growth or moldy odor.
- Replace water-damaged materials.

DO NOT

- Allow landscape sprinklers to strike buildings.

- Site portable classrooms over areas where water can collect.
- Use carpet in entryways to classrooms with direct outdoor access. If carpets are in place in such classrooms, supply waterproof mats over carpeted entryways for drying of clothing and umbrellas.

Communicating with Parents and Staff:

DO

- Develop an Indoor Air Quality Protection Policy for your school before there are problems. The U.S. E.P.A.'s "Tools for Schools" program can be implemented for little or no cost and can help districts involve everyone in maintaining good classroom indoor air quality.
- Respond promptly to staff or parental concerns about water leakage, mold growth or unusual illnesses in classrooms.
- If a water leak or mold growth is discovered, admit its presence. Be honest, frank, and open when discussing school facilities and potential environmental health issues.
- Inform the school community of the steps being taken to correct the problem and when remediation is expected to be complete.
- Release and discuss information found during classroom inspections (especially reports from external consultants) as rapidly as possible. Consider using the school website for this purpose.
- Involve parents and staff in discussions about prioritizing facility repairs if large expenditures are necessary and remediation cannot be done immediately.
- Encourage small group discussions or one-to-one question and answer sessions rather than large public meetings. Smaller groups are more likely to produce viable options for managing the current situation.

DO NOT

- Withhold information such as consultant reports or remediation plans from the school community while second opinions or technical reviews are being conducted.

We encourage concerned parents and others to work with school administrators and school board members regarding indoor mold issues or other environmental conditions that they believe may be affecting student or teacher performance or health.

Resources available to assist schools in maintaining good indoor air quality

Many water intrusion problems can be corrected and potential cases of mold growth prevented with timely maintenance and repairs by school district staff. The U.S. E.P.A. has developed the *Indoor Air Quality Tools for Schools Action Kit*, a free "do-it-yourself" guide to implementing a total indoor air quality program for individual schools. This program has been useful in many school districts in California by helping participants recognize situations that can lead to mold growth or other indoor air problems and either avoid or quickly address them.

Resources

- U.S. Environmental Protection Agency — *Mold Remediation in Schools and Commercial Buildings*
  http://www.epa.gov/iaq/molds/
- U.S. Environmental Protection Agency — *Indoor Air Quality Tools for Schools*
  http://www.epa.gov/iaq/schools/index.html
- New York City Department of Health — *Guidelines on Assessment and Remediation of Fungi in Indoor Environments* (April, 2000)
  http://www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html
- For general information about molds and health, as well as cleanup recommendations, please see these websites:
  http://www.cal-iaq.org
  http://www.dhs.ca.gov/ps/deodc/ehib/EHIB2/topics/mold.html

Questions and Answers

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ADVISORY ON RELOCATABLE AND RENOVATED CLASSROOMS

PURPOSE: This document summarizes the indoor environmental quality (IEQ) considerations regarding the purchase/lease of relocatable classrooms (or "portables") and the contracting for renovation of existing space. It is provided to advise school facility managers how to minimize potential health impacts from IEQ problems with cost-effective practices. The key IEQ concerns address design, construction/installation, first-use, and maintenance; some of the issues apply both to "portables" and renovated classrooms. Related documents where further technical details may be found are also listed.

A. DESIGN

The State Department of General Services (DGS) issues specifications on "Building, Classroom, Prefabricated, Relocatable General Requirements", which outlines the DGS requirements for the State Portable Classroom Program. The demand generated by the Class Size Reduction Program exhausted the available inventory of state lease program relocatable classrooms. Many school districts will instead obtain relocatable classrooms directly from manufacturers. Although all classroom units manufactured for California must conform to the Building Standards Code (Title 24), these standards are not specific for "portables". Hence, these relocatable units may not adhere to the DGS specifications, and their design and quality can vary.

Ventilation and Outdoor Air

For the design of heating, ventilation, and air conditioning (HVAC) systems, the ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers) Standard 62-1989 **Ventilation for Acceptable Indoor Air Quality** recommends 15 cubic feet per minute (cfm) per person of outdoor air for school classrooms. This value has been incorporated into the California Energy-Efficiency Building Standards. The DGS bid specifications for Relocatable Classrooms require that HVAC systems deliver a minimum of 480 cfm of total outdoor air. To achieve the ASHRAE Standard, this supply of outdoor air limits classroom occupancy in relocatable classrooms to no more than 32 persons.

When specifying a new relocatable classroom, ensure that the HVAC system can: (a) provide the minimum outdoor air stated above; and (b) heat and cool this outdoor air at design outdoor temperatures for the specific geographic location where each classroom is installed. Some manufacturers of relocatable units do not include outdoor air intakes in their standard classroom models. It is important that an additional "outdoor air kit" be ordered for this purpose. Further, installation of an outdoor intake must be specified as part of the exhaust system. Lack of an exhaust in an HVAC system with an outdoor air intake will result in room pressurization, reduced outdoor air flow rates, and lower efficiency of removal of pollutants from the room.

Outdoor air must be supplied continuously when a classroom is occupied. Demand-controlled HVAC package systems often used in relocatable classrooms typically operate only when the temperature of a space is different from the thermostat's set point (i.e., higher in the winter, and lower in the summer). In order to provide a continuous outdoor air supply, it is important to ensure that the HVAC thermostats are set in the "on" or continuous mode when occupied.

State-leased relocatable classrooms are required to have HVAC systems that are wall mounted. Units acquired from other sources can have either wall- or roof-mounted HVAC; the cost of roof-mounted HVAC may be somewhat

greater. However, some side-mounted units may be noisier, and it is important to check the noise level from HVAC operations in the relocatable classroom. If a noisy HVAC system is turned off because it interferes with classroom activities, this effects a failure of the ventilation requirement.

Air Filters for HVAC Supply Systems

Particle filters are needed for protection of HVAC components and reduction of airborne dust, pollens and microorganisms from recirculated and outdoor air streams. For relocatable classrooms, the DGS requires installation of a replaceable filter in the HVAC system. ASHRAE Standard 62-1989R requires filters with minimum of 25-30% dust spot efficiency (ASHRAE Standard 52.1) or >60% efficiency (ASHRAE Standard 52.2 for 3 micron particle). Where system design can accommodate them, filters with >65% efficiency for 1 to 3 micron particles will improve IAQ with respect to particles.

Renovating Classrooms

When school facilities are renovated for classroom use, it is imperative that new designs provide for adequate outdoor air in the renovated spaces. A common problem occurs when a large room is retrofitted with interior walls to create several, smaller rooms, and the required number of air supply outlets or return inlets is not installed. This results in inadequate ventilation in parts or all of the renovated rooms. Ensure that new designs are evaluated for ventilation adequacies.

Flooring materials

In most school classroom settings, hard flooring surfaces, such as commercial sheet flooring, are preferable to carpet: they are easier to keep clean, and they are not as prone to water damage or mold growth. However, the DGS State Portable Classroom Program requires that units be carpeted, except in certain areas, such as bathrooms. When carpets are specified, require the classroom manufacturer to install carpets that have been certified under the Carpet and Rug Institute's Indoor Air Quality Labeling Program.

Other important issues

- Site classrooms away from locations where: (a) vehicles idle, (b) water accumulates after rains, and (c) electric/magnetic fields (EMF) are high.
- Ensure that at least one supply air outlet and return air inlet are located in each enclosed area.
- Ensure that building air intakes are located away from any exhaust outlet(s) or other contaminant sources.
- Specify operable windows, to provide user-controlled ventilation when needed.
- Do not use carpet in entryways to classrooms with direct outdoor access. Otherwise, supply waterproof mats over carpeted entryways for drying of clothing and umbrellas.
- Check that special-use classrooms (e.g., for chemistry, biology, fine arts, etc.) have local exhaust ventilation (e.g., hoods or window fans).
- Locate HVAC and air handler units as far away as possible from teaching areas.
- Have insulation installed only on the outside surfaces (not inside) of air ducts.
- Ensure that HVAC ducts and plenums have easy access for inspection and cleaning.
- Specify that building materials used in construction (e.g., paints and adhesives) and room furnishings (e.g., particle-board bookcases) are certified as “low-emitting” for volatile organic compounds (VOCs).

B. CONSTRUCTION/INSTALLATION and FIRST-USE

Building construction and renovation create dust, emissions of volatile organic compounds (VOCs), and other work hazards and these are not compatible with normal school functions. A large proportion of building-related illness is associated with the improper use or storage of building materials in occupied areas. Therefore, every effort should be made to restrict construction activities to non-sc ool hours and to ensure that building materials are stored away from occupied areas.

Isolate construction areas

During construction, it is important to isolate construction activities from occupied areas with a floor-to-ceiling

barrier that will contain dust and vapor, such as plastic sheeting. Exhaust-to-outside ventilation in construction areas should be used at all times when dust or chemical vapors are generated.

Commission HVAC system in relocatable classrooms

Before a relocatable classroom is used, be certain that the HVAC system is fully inspected by a certified professional. Have him/her certify that it heats and cools properly, provides the appropriate amount of outdoor air, and operates continuously when the classrooms are occupied. The space pressure of the building should be slightly positive with respect to outdoors. Check the noise level in the classroom associated with HVAC operation. Confirm that outdoor air intakes are located away from contaminant sources (e.g., bus parking, kitchen exhaust, etc.).

"Flush-out" all newly constructed, remodeled, or acquired classrooms.

Prior to use of any new relocatable units by staff or students, operate HVAC systems at their maximum outdoor air intake rate continuously for several days. Similarly, provide maximum flush-out by HVAC (or open windows) for newly renovated classrooms and offices. Start this "flush-out" as soon as the HVAC system is operational, and continue after furniture installation. During this period, do not recirculate return air.

"Flush-out" not "Bake-out"

Building "bake-outs", i.e., when temperatures are increased up to $\simeq 100°F$ in order to "artificially age" building materials, are not recommended. Their effectiveness has not been proven, and they may in fact damage parts of the HVAC system or building components.

Continue "flush-out" ventilation during periods of first use

Efforts to minimize exposures to school children and staff should continue in the weeks following project completion. Emissions of VOCs from building materials still pose problems during this time, when they are at their highest. This is done by delaying occupancy in renovated rooms and portable classroom for several weeks, and utilizing maximum outdoor air ("flush-out") ventilation during these periods and for the first weeks of use. Flush out periods of 1-2 weeks are recommend, although longer periods may be required. For the first days to weeks of occupant use, continue to operate HVAC systems at the maximum outdoor air setting. Finally, monitor occupants' comfort, and follow-up complaints to identify problems early.

Establish an Integrated Pesticide Management plan.

For a quick reference guide, see *Pest Control in the School Environment: Adopting Integrated Pest Management*, Report EPA 735-F-93-012 (available from the U.S. EPA Indoor Air Quality Information Clearinghouse, see below).

C. MAINTENANCE

The cost of new classrooms is an investment in the future of a school. It is clear that adequate maintenance is key to protecting this investment: *An ounce of prevention is worth a pound of cure.*

- Designate specific personnel to perform specific tasks:
- Provide training on operation and maintenance of new HVAC equipment to appropriate staff.
- Be certain that operation and maintenance (O&M) documentation is kept readily accessible to staff servicing the system.
- Maintain documentation of completed tasks.
- Allocate sufficient staff time and funds for maintenance.
- Instruct teachers and staff on proper use and settings of thermostat and ventilation controls -- provide each classroom with hardcopy (plastic-covered) instruction sheets.

Establish a regular and timely plan for testing, inspecting and performing specific maintenance tasks:

- Inspect roofs, ceilings, walls, floor, and carpeting for evidence of water leakage or infiltration, and for mold and mildew growth or odor. **Replace water-damaged materials.**
- Inspect air supply outlets and return air inlets, to ensure that they are open, operable and unobstructed.
- Check airflows rates at the outlets and inlets periodically.
- Inspect air plenums for mold growth, excess dirt, etc.
- Establish a periodic air filter replacement schedule.
- Clean condensate pans (monthly) and do not allow free standing water to accumulate.
- When carpets are cleaned, ensure that they dry thoroughly as soon as possible after the process is done.
- Provide for the proper storage of cleaning/janitorial supplies.
- Maintain documentation of completed tasks.

RELEVANT PUBLICATIONS

- *IAQ Tools for Schools Action Kit*. For information, contact the U.S. EPA IAQ Information Clearinghouse (see below). This kit provides guidance for achieving and maintaining good IAQ in your schools.
- *Indoor Air Quality: A Guide for Educators.* Available from the California Department of Education, School Facilities Planning Division (see below).
- *Building Air Quality: A Guide For Building Owners and Facility Managers*. Available from the Superintendent of Documents, FAX: 202-512-2250.
- *Pest Control in the School Environment: Adopting Integrated Pest Management*, Report EPA 735-F-93-012 (available from the U.S. EPA IAQ Information Clearinghouse (see below).
- *Indoor Air Quality / School Facilities Documents* (a set of 15 documents, such as "Maintaining Acceptable IAQ During the Renovation of a School", "Maintenance of HVAC Systems and IAQ in Schools", and "Equipment for Measuring Air Flow, Air Temperature, Relative Humidity, and Carbon Dioxide in Schools"). Available from the Maryland State Department of Education, Schools Facilities Branch, 410-767-0100.
- *Reducing Occupant Exposure to Volatile Organic Compounds (VOCs) From Office Building Construction Materials: Non-Binding Guidelines*. Also applicable to school building construction. Available from DHS' Indoor Air Quality Section, see below.
- *Electric/Magnetic Field (EMF) Checklist for School Buildings and Grounds Construction*. Available from DHS' EMF Program, see below.

ADDITIONAL CONTACTS

- U.S. EPA Indoor Air Quality Information Clearinghouse, 800-438-4318.
- California Department of Education, School Facilities Planning Division, 916-322-2470 (Ellen Aasletten).
- California Department of Health Services (DHS) Indoor Air Quality Section, 510-540-2476 (Jed Waldman), and Electric/Magnetic Fields Program, 510-622-4500 (M.A. Stevenson).
- California Air Resources Board, Indoor Air Quality/Personal Exposure Assessment Program 916-323-1504 (Peggy Jenkins).
- Cal/OSHA Consultation Service. Contact headquarters (415-972-8515) or area office.
- California Energy Resources, Conservation & Development Commission (CEC), 916-654-4287.
- California Department of General Service (DGS) Office of Public Construction, 916-323-0319 and Division of the State Architect, 916-445-2163.
- Carpet and Rug Institute, 800-882-8846.
- School Facilities Manufacturers Association,
- National Pesticide Telecommunications Network: 800-858-7378.

This advisory was produced by the *California Interagency Working Group on Indoor Air Quality* in December 1996. Direct correspondences or comments to:

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Proper HVAC System Design in School Portables

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With the Statewide K-3 Class Size Reduction Program, the number of portable classrooms in California has increased dramatically. Many of these portables were brought in quickly to satisfy the classroom size requirements. Some have been in place for a number of years and may not have been originally designed for full time classroom use.

Often because portable buildings are considered temporary, they do not get the same HVAC system design consideration that a permanent school building would.

Some of the criteria that school districts should consider are summarized as follows:

1. Noise: The typical portable classroom uses a wall-mounted heat pump. The return air contains no ductwork to separate the unit from the classroom (In some instances, a student's head may be right in front of this return air opening). As such, noise generated by the unit is transmitted to the classroom. In many instances, teachers turn off the heat pump rather than to talk over it. When this happens, the classroom gets no ventilation.
2. Exhaust Air: Portables often are built with no exhaust air or even relief air provisions. It becomes difficult for the air conditioning unit to bring in fresh air when no means is provided for exhaust air. In this scenario, because of the energy code requirements to keep the building of tight construction, the room is pressurized and does not provide an outlet path for the fresh air.
3. Undersized equipment: Portables may be intended to be used as offices then later changed to classroom use. This may result in maintenance technicians minimizing outside air ventilation to enable the unit to maintain temperature setpoint on hot or cold "design days". The system needs to be re-evaluated when a change in use occurs. In some cases, portables are converted to computer rooms with no changes to the HVAC system.
4. Economizers, which can provide for more than minimum outside air when conditions are beneficial (cooler outside than inside when unit requires cooling), are poorly designed for the typical heat pump. Heat pumps typically use the condenser section as the exhaust section in economizer mode. This exposes the condenser fan to the classroom and creates more of a noise concern than normal operation. The typical economizer control also does not allow for "integrated economizers" (integrated economizers allow both economizer and cooling simultaneously). As such economizers are rarely utilized in the portable application.
5. Excessive duct leakage: After a period of years, settling and often movement of the portable building, excessive duct leakage from loose connections occurs (duct tape is often used in joints which dries out over a period of years). This leakage precludes ventilation getting into the classroom.

Evaluation of 32 portable classrooms - including portables of different ages and types, was completed for seven Milpitas school sites. Implemented upgrades included:

1. Exhaust fans were added to all rooms. The exhaust fans were controlled by a dual technology occupancy sensor, so that anytime the room was occupied there would be proper ventilation. As an added feature, the lighting included with the occupancy sensor to achieve energy savings.
2. Outside air ventilation was increased from approximately 100 cfm (some even lower) to 525 cfm.
3. In a few portables the HVAC unit was replaced, as it was older and the noise generated was substantially more than in the other portables.
4. Several other units were replaced as they were undersized (they were changing from 3 ton to 4 ton units). New ductwork and supply grilles were installed on these units.
5. Two units to had the return modified to include a sound plenum.
6. Supply ducts on all existing systems were repaired which increased total supply air by approximately 20% on the worst units.

As is the case in any classroom, portables should be designed to meet ASHRAE Std. 62-1989 ventilation standards. The system must be commissioned to ensure that the ventilation standards can be met continuously. The costs to this project were not prohibitive. It is in the best interests of the students, teachers and staff, if all districts consider these upgrades where problems of this nature are identified.

Deciding Whether or Not to Have Your Air Ducts Cleaned

Knowledge about the potential benefits and possible problems of air duct cleaning is limited. Since conditions in every home are different, it is impossible to generalize about whether or not air duct cleaning in *your* home would be beneficial.

If no one in your household suffers from allergies or unexplained symptoms or illnesses and if, after a visual inspection of the inside of the ducts, you see no indication that your air ducts are contaminated with large deposits of dust or mold (no musty odor or visible mold growth), having your air ducts cleaned is probably unnecessary. It is normal for the return registers to get dusty as dust-laden air is pulled through the grate. This does not indicate that your air ducts are contaminated with heavy deposits of dust or debris; the registers can be easily vacuumed or removed and cleaned.

On the other hand, if family members are experiencing unusual or unexplained symptoms or illnesses that you think might be related to your home environment, you should discuss the situation with your doctor. EPA has published *Indoor Air Quality: An Introduction for Health Professionals* that can be obtained free of charge by contacting IAQINFO at the number listed in the back of this booklet. You may obtain another free EPA booklet from IAQINFO entitled *The Inside Story: A Guide to Indoor Air Quality* for guidance on identifying possible indoor air quality problems and ways to prevent or fix them.

You may consider having your air ducts cleaned simply because it seems logical that air ducts will get dirty over time and should occasionally be cleaned. While the debate about the value of periodic duct cleaning continues, no evidence suggests that such cleaning would be detrimental, *provided that it is done properly*.

On the other hand, if a service provider fails to follow proper duct cleaning procedures, duct cleaning can cause indoor air problems. For example, an inadequate vacuum collection system can release more dust, dirt, and other contaminants than if you had left the ducts alone. A careless or inadequately trained service provider can damage your ducts or heating and cooling system, possibly increasing your heating and air conditioning costs or forcing you to undertake difficult and costly repairs or replacements.

You should consider having the air ducts in your home cleaned if:

Ö**There is substantial visible mold growth inside hard surface (e.g., sheet metal) ducts or on other components of your heating and cooling system.** There are several important points to understand concerning mold detection in heating and cooling systems:

- Many sections of your heating and cooling system may not be accessible for a visible inspection, so ask the service provider to show you any mold they say exists.

- You should be aware that although a substance may look like mold, a positive determination of whether it *is* mold or not can be made only by an expert and may require laboratory analysis for final confirmation. For about $50, some microbiology laboratories can tell you whether a sample sent to them on a clear strip of sticky household tape is mold or simply a substance that resembles it.

- If you have insulated air ducts and the insulation gets wet or moldy, it cannot be effectively cleaned and should be removed and replaced.

- If the conditions causing the mold growth in the first place are not corrected, mold growth will recur.

Ö **Ducts are infested with vermin, (e.g., rodents or insects); or**

Ö **Ducts are clogged with excessive amounts of dust and debris and/or particles are actually released into the home from your supply registers.**

Other Important Considerations...

Duct cleaning has never been shown to actually prevent health problems. Studies have not conclusively demonstrated that particle (e.g., dust) levels in homes increase because of dirty air ducts or go down after cleaning. This is because much of the dirt that may accumulate inside air ducts adheres to duct surfaces and does not necessarily enter the living space. It is important to keep in mind that dirty air ducts are only one of many possible sources of particles that are present in homes. Pollutants that enter the home both from outdoors and indoor activities such as cooking, cleaning, smoking, or just moving around can cause greater exposure to contaminants than dirty air ducts. Moreover, there is no evidence that a light amount of household dust or other particulate matter *in air ducts* poses any risk to health.

EPA does *not* recommend that air ducts be cleaned except on an as-needed basis because of the continuing uncertainty about the benefits of duct cleaning under most circumstances. If a service provider or advertiser asserts that EPA recommends routine duct cleaning or makes claims about its health benefits, you should notify EPA by writing to the address listed in the back of this booklet. EPA does, however, recommend that if you have a fuel burning furnace, stove, or fireplace, they be inspected for proper functioning and serviced before each heating season to protect against carbon monoxide poisoning. Some research also suggests that cleaning dirty cooling coils, fans, and heat exchangers can improve the efficiency of heating and cooling systems. However, little evidence exists to indicate that simply cleaning the duct system will increase your system's efficiency.

If you think duct cleaning might be a good idea for your home, but you are not sure, talk to a professional. The company that services your heating and cooling system may be a good source of advice. You may also want to contact professional duct cleaning service providers and ask them about the services they provide. Remember, they are trying to sell you a service, so ask questions and insist on complete and knowledgeable answers.

Indoor Air Quality Tools for Schools

Effective Facility Maintenance for Healthy, High Performance Schools

e-Newsletter

April 2006, Volume 4

The Facility Director's Role in IAQ Management

Often the school community assumes that the facility and custodial staff are responsible for ensuring good indoor air quality (IAQ). However, every occupant of the school building has a stake in its air quality. Therefore, everyone has a role to play in addressing IAQ issues and taking action to prevent problems from developing. Because of their knowledge of the school's building systems (e.g., heating, ventilation, and air conditioning (HVAC) equipment), cleaning, and maintenance policies and procedures, the facility directors are often a logical choice to lead a school's efforts to implement a proactive IAQ Management Plan.

Good IAQ can take on a variety of forms in a school. From a well-controlled climate in classrooms to the selection and use of non-toxic cleaning products, facility directors can take steps to ensure a safe and healthy working environment for staff and learning environment for students. The school facility director is in the unique position of being able to see the "big picture" of the school's environmental conditions. Often, the facility director has input on purchasing and management decisions that can affect the school facility. Facility staff interact with students, teachers, administrative staff, and other school personnel on a regular basis. This often provides the facilities staff with the unique ability to see all the components of the total school environment, rather than just isolated pieces.

The *Indoor Air Quality Tools for Schools* (*IAQ TfS*) Kit provides guidance for establishing and implementing an effective IAQ management program. The Kit provides a variety of tools (from background informational pieces to checklists and instructional videos) designed to walk school personnel through the entire process of developing an IAQ management plan. The IAQ Coordinator's Guide contains model policies for addressing issues related to the indoor environment such as radon, pest management, mold & moisture, among others. The Facility Director is a logical choice to lead the schools efforts to develop and implement an IAQ management program in a school or district and EPA has the resources to help.

Managing Mold and Moisture in Schools

One of the growing environmental issues facing schools today is the problem of unplanned moisture and the subsequent growth of mold. Exposure to mold can often lead to a variety of health effects and symptoms including allergic reactions and increased asthma attacks in

The Charlotte-Mecklenberg School District: *Focus on Facilities*

Like many school districts, the Charlotte-Mecklenberg (NC) Public Schools' (the 25th largest school district in the country) introduction to indoor air quality took the form of negative media attention. Several parents raised concerns that their children were becoming sick due to mold exposure in one of the district's older buildings. While the district took quick action to begin an investigation into possible mold concerns, the parents contacted the local media which generated unfavorable media coverage about the district. Trace amounts of mold were found in the building, which resulted in $100,000 of renovations, including a new HVAC system.

Prior to the negative media attention surrounding the mold concern, Charlotte-Mecklenberg Schools primarily dealt with IAQ on a reactive basis, like many districts across the country. No formal IAQ management plan existed, and prevention and resolution of IAQ problems was not integrated into the district's day-to-day functioning. With 150 school buildings and over 117,000 students and staff, the district realized that a formal management plan was needed to address IAQ issues proactively and to avoid another mold "crisis."

Among the first steps taken by the district was to obtain a copy of the *IAQ Tools for Schools* (*IAQ TfS*) Kit and appoint an IAQ Coordinator to oversee the implementation process. The district's safety officer was selected to fill this important position with support from the highest levels of district administration. Each school principal was designated as the on-site IAQ contact helping to manage information sharing, coordinate education about IAQ issues, and ensure that IAQ concerns were forwarded to the district facility staff who would investigate the problem.

As is often the case, one of the biggest challenges implementing an IAQ management program is educating all school staff about the importance of IAQ and each person's role in maintaining good IAQ. To illustrate these concepts, the IAQ team combined several of the checklists contained in the *IAQ TfS* Kit, to create an "Occupant Checklist." Training courses, conducted during staff meetings, were held to educate school staff about IAQ and the district's emerging IAQ Management Plan. Throughout the process, communications between facility staff, the administration, each school's IAQ contact, and school staff were essential in ensuring the development of a management program that would be effective.

sensitive individuals. In an era of tight school budgets, dealing with a mold or moisture problem can create additional strain on facility budgets that may already be stretched too thin. Many facility directors are confronted with a mold problem and are unsure how to proceed. Facility directors may wonder: what are some simple steps that my in-house staff can take to reduce moisture and mold problems? How do I know if I have a mold problem in my school? When should the school district look to an outside contractor for assistance? How do I identify qualified mold contractors?

In 2001, EPA released "Mold Remediation in Schools and Commercial Buildings" to address the questions listed above. This document presents background information on the potential health effects of mold and guidelines for the remediation/clean up of mold and moisture problems in schools and commercial buildings. These guidelines include measures designed to protect the health of building occupants and remediators. It was designed primarily for building managers, custodians, and others who are responsible for school maintenance and can serve as a reference for potential mold and moisture remediators. Individuals with little or no experience with mold remediation should be able to make a reasonable judgment as to whether the situation can be handled in-house. It can help those in charge of maintenance to evaluate an in-house remediation plan or a remediation plan submitted by an outside contractor.

The document contains guidance on how to prevent moisture problems from developing; how to assess water damage and conduct clean up activities to prevent mold growth; and remediation guidelines should a mold problem emerge. The following is a sampling of some of the items a school facility director should address when assessing a moisture problem and dealing with mold growth.

Investigate and evaluate moisture and mold problems

- Assess size of moldy area (square feet).
- Consider the possibility of hidden mold.
- Clean up small mold problems and fix moisture problems before they become large problems.
- Select a remediation manager for medium or large size mold problems.
- Investigate areas associated with occupant complaints.
- Identify source(s) or cause(s) of water or moisture problem(s).
- Note type of water-damaged materials (wallboard, carpet,etc).
- Check inside air ducts and air handling unit.
- Throughout process, consult qualified professional, if necessary or desired.

Remediate moisture and mold problems

- Fix moisture problems, implement repair plan and/or maintenance plan.
- Dry wet materials within 24-48 hours to prevent mold growth.
- Clean and dry moldy non-porous materials.
- Discard moldy porous items that can't be cleaned.

Today, the Charlotte-Mecklenberg School District has an effective, proactive IAQ management program in place. While the facilities department still takes the lead on collecting and responding to IAQ problems, everyone in the district is involved in the process. The district has instituted a formal IAQ incident organizational chart to track the work-flow of an IAQ complaint. Every complaint is investigated within 24 hours. Any corrective action taken is communicated back to personnel in the school. The district now has a written IAQ management plan and awareness and importance of IAQ issues among district staff is at the highest level. The Facilities Department is now seen as effectively working to address IAQ and other problems, as well as helping to create a healthier environment for students and staff.

The Charlotte-Mecklenberg Schools took an unfortunate situation (i.e., negative media attention regarding a mold problem) and used that as the basis for establishing an active IAQ management program. Although the Facilities Department led the effort to implement the *IAQ TfS* Program, personnel from the entire district became involved in the process. Now IAQ is not perceived as just "a facilities issue." Rather, the Facilities Department plays the key role in coordinating the IAQ management plan, while also soliciting valuable information from the entire school staff. In 2004, Charlotte-Mecklenberg Schools was a recipient of EPA's *IAQ TfS* Excellence Award. They are also a member of the American Association of School Administrators Urban Resource Coalition.

Top Ten Tips for Facility Managers

1. Implement a comprehensive, district-wide indoor air quality maintenance program consistent with the U.S. EPA's ***IAQ TfS*** Program.
2. Conduct regular building walkthrough inspections, and measure temperature, relative humidity, carbon monoxide, and carbon dioxide. Following the school walkthrough, identify and prioritize indoor air quality problems in the school.
3. Ensure that all HVAC system air supply diffusers, return registers, and outside air intakes are clean and unobstructed. Regularly change filters and ensure condensate (or drip) pans are draining properly.
4. In order to flush polluted air out of the school, bring adequate outdoor air into the building using the **school ventilation system**. Maintain minimum outdoor air ventilation rates consistent with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard 62.1, which for classrooms is about 15 cubic feet per minute (cfm) of outdoor air per person.
5. Maintain indoor humidity levels between 30 percent and 60 percent to ensure comfort and reduce problems with **mold** and bacteria.

The key to resolving moisture and mold problems in schools is a combination of quick action and effective communications.

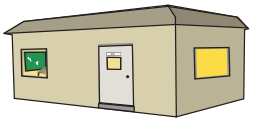
*For more information about moisture and mold and to obtain a copy of "Mold Remediation in Schools and Commercial Buildings," visit: www.epa.gov/mold. For information on effective communications about IAQ in schools, please see EPA's "*IAQ Tools for Schools *Communications Guide" available online at: www.epa.gov/iaq/schools/images/communication_guide.pdf.*

Facilities Spotlight: *The School Debate about Portable Classrooms*

Portable classrooms, also commonly known as "trailers," "portables," "temporaries," "relocatables," or "modulars," have been a feature of many school districts' building stock for years. From a school district's perspective they provide a quick and relatively inexpensive way to address unpredictable peaks in school enrollment, limited building construction funds, and the time lag between identifying the need for more space and the time for constructing new facilities. However, for many school districts, portable classrooms are seldom moved and become permanent fixtures of the school.

Recent surges in student populations in some parts of the country have fueled an explosion in the use of portable classrooms, raising concerns about the healthfulness of portable classrooms.

What is a Portable Classroom?



By definition, structures smaller than 2,000 square feet are considered "portable," but the distinction between "portable" and "not portable" can be easily blurred by manufacturers who often build structures larger than 2,000 square feet with relocation in mind.

Building design and materials used distinguish temporary from permanent portable classrooms. Temporary portable classrooms are inexpensive, pre-fabricated units that offer a limited choice of construction materials and mechanical systems. Permanent portables come custom-built as either stand-alone structures or additions to existing conventional structures. Today, manufacturers can produce temporary or permanent, single room or multi-story portables with concrete floors, brick exteriors, cable hook-ups, electrical systems, plumbing systems, HVAC systems, and bathrooms. These classrooms can look so complete that they are difficult to distinguish from conventional school buildings.

Benefits of Portable Classrooms

The use of portable classrooms has become more widespread, as they are a quick and relatively inexpensive solution to a variety of challenges that schools may encounter.

- Portables relieve overcrowding in original school buildings and help to reduce the student-to-teacher ratio.
- Temperature and air-conditioning settings can be controlled on a room-by-room basis.
- Portable classrooms allow school districts to provide extra space quickly, as they can easily be moved from one site to another and can be assembled quickly. For example, the state of California owns several portable classrooms and leases them on an as-needed basis to school districts throughout the state.
- Construction of portable classrooms does not place as much demand on school administrators for organization and management of construction companies as conventional classrooms. Manufacturers of portables assume total responsibility for architectural design, construction, and project management on their own construction sites before they are delivered to the school.

Several attractive options are available for financing portable classrooms, such as purchase, lease, or lease-to-buy.

6. Regularly clean and remove dust from hard surfaces with a damp cloth, and vacuum using high-efficiency filters.
7. Follow the U.S. EPA's guidelines for the **prevention and remediation of mold**.
8. Promptly fix moisture problems, including those from roof, window, and plumbing leaks. Thoroughly dry wet areas within 24-48 hours to prevent mold growth.
9. Employ **integrated pest management** (IPM) methods in your school instead of traditional pesticide-based methods.
10. Use low volatile organic compound (VOC) paints, adhesives, and cleaning products that emit lower levels of gases into the air.

The Ten Tips for Facility Managers are just a few of the many ways that school facilities staff can impact the indoor environment. In many cases, the facility staff may already be implementing these measures, but have not thought about them in the context of a comprehensive IAQ management program. One primary purpose of the *IAQ TfS* Program is to help school facility staff incorporate policies and procedures already in place with additional steps that can be taken to create a healthy learning environment. Controlling pollutants, maintaining building systems, and establishing effective communications procedures can help create a healthy and safe, high performance educational environment.

For more information on how a facility director and facilities staff can be involved in school IAQ management, visit EPA's IAQ TfS Program Web site at www.epa.gov/iaq/schools.

Portables can cost as little as one-third as much as conventional classrooms. On their balance sheets, schools can list portables as tangible assets that can be re-sold. In spite of the supporting arguments for cost savings, convenience, and other benefits of portables, public perception of the potential environmental and health impacts attributable to portables overrides their widespread acceptance.

Common Concerns about Portable Classrooms

Criticism of portable classrooms spans a range of concerns, from aesthetic complaints to poor air circulation. While some people may find portable classrooms unsightly, issues of overcrowding in schools and potential health risks associated with portables have received the most attention from parents, media, government, and school administrators in recent years.

The most common problems with portable classrooms include:

- Poorly functioning HVAC systems that provide minimal ventilation with outside air.
- Poor acoustics from loud ventilation systems.
- Chemical off-gassing from pressed-wood and other high-emission materials may be of greater concern because there is often a higher usage of these products in portables.
- Water entry and mold growth.
- Site pollution from nearby parking lots or loading areas.

Environmental groups, doctors, and researchers contend that portable classrooms are more prone to IAQ problems than conventional classrooms. They argue that the combination of materials used in construction, tighter construction design (originally intended to save energy), smaller buildings, fewer windows, and inadequate ventilation in portable classrooms can lead to a greater build-up of indoor air pollutants than in conventional school buildings. According to the publication "Reading, Writing and Risk: Air Pollution Inside California's Classrooms," higher concentrations of volatile organic compounds (VOCs) have been found in some portable classrooms than in traditional school buildings. Materials used in new portable classroom construction, such as pressed-wood products, contain higher concentrations of formaldehyde, if not properly off-gassed, the result could be elevated levels of airborne chemicals, especially if ventilation is reduced.

Because portable classrooms are intended only for temporary use, although they often become permanent installations, the products selected for portables may be of lower quality than those purchased for permanent classrooms. Care should be taken during specification and selection to ensure that the students' health is not compromised for inexpensive, low quality designs. When districts specify a portable design, they typically create a term contract that other districts can use to purchase the same (or slightly different) design. This practice (often called "piggy-backing") can save a district valuable time and money on specifications and approvals, but it can also compound poor decisions made in the original procurement.

California Study on Portable Classrooms

In November 2003, the California Air Resources Board and the California Department of Health Services issued a report on a study of the use of portable classrooms by school districts in California. This report of the use of portable classrooms in California is the most in-depth study to date. California is one of the most widespread users of portable classrooms in the U.S. because of exponential growth in student enrollment in California's public schools. In a projection report, the Department of Education indicated that, between 2001 and 2013, school enrollment in California will increase an astounding 15.7 percent. Portable classrooms help schools resolve the dilemma of where to house this influx of students. The report indicated that portable classrooms have more HVAC problems than traditional classrooms, including higher rates of dirty air filters, blocked outdoor air dampers, and poor condensate drainage, which can lead to microbial contamination. The report also claimed that teachers in portable classrooms turn off ventilation systems 60 percent of the time due to excessive noise. By comparison, in conventional classrooms, teachers turn off ventilation systems 23 percent of the time due to excess noise. In the report, the California Air Resources Board and California Department of Health Services offered recommendations for maintaining healthy classroom environments, applicable for both portable and conventional classrooms. Unfortunately, this study did not provide the answer to the debate of whether portable classrooms adversely impact children's health more than conventional classrooms. In closing, the report encouraged schools to develop and require full building commissioning procedures for new buildings and classrooms to ensure proper building performance from the start, including testing for lighting, HVAC, and other building systems.

Recommendations for Schools Using Portables

For schools choosing to lease or purchase portables, the following steps can help them to maintain a healthy indoor environment.

- To prevent IAQ from becoming a problem, train facilities and maintenance staff to maintain portables and conventional classrooms properly and consistently.
- Establish a schedule for replacing filters, checking vents, dampers, moisture levels, etc.
- Educate teachers on how their actions contribute to the quality of the school's indoor environment.
- Develop and implement a "watch" list for teachers to use in their classrooms. Include items such as turning

Maintaining Healthy IAQ in Portables

One key approach to avoiding potential IAQ problems in portable classrooms is ventilation. The amount of outside air delivered to most classrooms is often inadequate due to improper use or operation of HVAC systems. For example, outside air dampers are frequently closed or set too low, either as an energy-saving technique or because the HVAC systems arrived from the manufacturer with the dampers set in the fully closed position—a shipping requirement that schools often fail to notice. A California study showed that 60% of teachers in portables sometimes turn their HVAC systems off due to excessive noise. Some ventilation systems have never had their air filters changed or are operating with packing and shipping materials still inside the unit. It is critical that schools perform routine maintenance of ventilation systems and educate teachers, particularly those with access to classroom HVAC controls, on how to properly maintain and operate classroom ventilation systems.

The same problems—lack of ventilation, improper cleaning and maintenance, poorly functioning HVAC, and others—can exist in any indoor environment. Like all school facilities, portable classrooms should contain appropriate building and indoor surface materials and properly designed ventilation systems to minimize the presence of indoor pollutants. Commissioning and regular maintenance are important to maintaining the quality of the indoor environment in portable classrooms and school facilities.

Facility Maintenance During Vacation:
A Spotlight on Floor Covering Decisions

While many members of the school community look forward to vacation (spring, summer, and holiday breaks), for the facilities department, this marks the beginning of a major period of activity. Large cleaning, renovation, and repair projects often occur during these breaks. As the school year moves forward, maintaining the indoor environment for students should be a top priority for facilities staff and custodians. Facilities and maintenance staff can use vacation time as an opportunity to refresh and update maintenance practices. They should also conduct building walkthroughs of the school using maintenance and walkthrough checklists provided in EPA's *IAQ TfS* Kit. Beginning this process before students return from school breaks makes it easier for facilities staff.

Floor Covering

One area of particular concern to facilities staff is selecting and maintaining floor coverings. Due to decreased traffic

on vents one hour before class starts, watching for rust spots, wet spots, and other signs of deterioration of infrastructure.

- Educate teachers about the potential risks of turning off HVAC systems.
- Follow installation and maintenance instructions for the systems provided by the manufacturer.
- Ensure the portable's HVAC system is designed and operated to provide a minimum outdoor air ventilation rate consistent with ASHRAE Standard 62.1, which for classrooms is about 15 cfm of outdoor air per person. Outdoor air should be provided continuously when a classroom is occupied.
- Prior to use of any new portable classrooms by staff or students, HVAC systems can be operated at their maximum outdoor air intake rate continuously for several days to "flush out" pollutants. During this period outdoor air should be thermally conditioned (i.e. heated or cooled), as needed, to typical indoor temperatures.
- Check for stains or rust spots that indicate water exposure. Fix moisture problems, implement repair plan and/or maintenance plan.
- Specify and request particle board that is free of urea-formaldehyde resins in all construction and purchasing, even though it may be 30 percent more expensive. Formaldehyde is a hazardous air pollutant, as identified in the 1990 Clean Air Act and is classified as a carcinogen.
- Identify which windows may be opened by occupants, which can provide fresh air exchange and natural ventilation, to supplement the mechanical ventilation provided by the HVAC system.
- Place portables away from sprinkler systems and other sources that can lead to excessive moisture or collection of rainwater around the foundation.
- Locate classrooms away from areas where vehicles idle. Make sure that building air intakes are located away from any exhaust outlets or other contaminant sources to prevent the intake of exhaust from school buses and cars and pollutants from other outdoor contaminant sources.
- Do not use carpets in entry-ways to classrooms with direct outdoor access. This allows for the collection of water, dirt, or other pollutants that can easily be tracked into the room. Supply waterproof mats over entryways and other areas used for drying clothing and umbrellas. Clean up any water on the floor or walls as soon as it's apparent.
- Check that special-use classrooms (e.g., chemistry, biology, fine arts) using chemical or odor-producing products have local exhaust ventilation.

throughout the school building during the school break, this may be an ideal time for conducting renovation and replacement activities relating to flooring. What information is available to assist the facilities department in making these decisions?

At EPA's 5th Annual *IAQ TfS* Symposium in December 2004, professionals in the field of facility management conducted a panel discussion on the topic of floor coverings, facility maintenance, and the effect of different flooring types on IAQ in schools. The process of reviewing options and selecting products for use in schools should consider the ultimate goal of building design and maintenance: creating and maintaining a healthy, high performance learning environment. For some areas in schools (like cafeterias), hard flooring is an obvious choice. However, determining appropriate floor coverings for such areas as classrooms and hallways requires more thought and consideration. The process of selecting the best floor covering for a particular area of the building should consider the following criteria: the initial cost (purchase and installation), the life cycle cost (cost to maintain and longevity), the product's effect on IAQ (e.g., toxicity of material, VOC content, cleaning products and methods), the product's impact on the learning environment (e.g., acoustics, lighting, thermal comfort, safety), and the preferred product. Use these criteria to evaluate options of floor coverings and determine the best and most rational flooring option for each area of the school building.

A major consideration in selecting appropriate floor coverings is the cost of cleaning the product. Cleaning is the essential ingredient to create and maintain a healthy and safe, high performance indoor environment. Clean buildings are less expensive to maintain than dirty buildings. Preventive maintenance and proactive cleaning practices help to reduce the overall cost and time required to maintain school buildings.

Administrative commitment and buy-in is important to secure support for the maintenance of healthy, high performing schools. Administrators can approve funding for professional development and training for facilities personnel on proper maintenance procedures. Professional development is a worthwhile investment for schools. Custodians and maintenance staff are the "guardians" of a school's indoor environment. As such, they "must be well-trained, skilled, and professional in order to create a quality environment, prevent accidents, recognize warning signs, troubleshoot emergencies, and have complete facility operation awareness." (NEA HIN, 2004) Providing facilities staff with opportunities for professional education will help administrators to ensure that their facilities staff have the professional training necessary to select appropriate materials for the maintenance of school facilities as well as the knowledge of appropriate cleaning procedures that will ensure routine maintenance of high performing schools.

Conclusion

Even if the U.S. were not facing an impending school-age population boom, school districts would still have portables among their preferred options for accommodating students because of their convenience, flexibility, and cost effectiveness. Portable classrooms will be a part of school landscapes for a long time to come, and schools need to ensure that portable learning environments are as safe as conventional classrooms. School districts need to pay attention to the basic principles of building ventilation, location, and maintenance for portables to ensure that all classrooms, not just portables, are welcoming and safe spaces where children can perform well.

How to Choose and Maintain Floor Coverings

- Use walk-off mats at every building entrance to prevent tracking in dirt, water, and other pollutants from outdoors.
- Select floor coverings appropriate for the function of each space (e.g., use resilient floor coverings in cafeterias, art rooms, science rooms, and other areas where spills are likely; use carpet in quiet areas such as administrative areas and libraries).
- Choose products with low VOC emissions (e.g., carpets with no wet adhesives, resilient flooring with low-VOC adhesives).
- Use products with proven track records for quality and durability.
- If carpet is specified, ensure the carpet, cushion, and adhesive are constructed to prevent liquids from penetrating the backing layer where moisture under the carpet can result in mold growth.
- Only use cleaners that do not leave behind detergent residue.
- If available, select carpets with 100% certified recycled content backing.

Be Proactive to Ensure a Healthy, High Performing School

Proactive facility maintenance and cleaning is essential, especially over school breaks, to maintain a clean and healthy, high performance school environment. Following appropriate protocols for maintaining healthy buildings and using safe and effective cleaning practices can help to limit health risks resulting from unnecessary human exposure to hazardous products. EPA's *IAQ TfS* Program and Kit and related programs offer a wealth of useful tips and voluntary guidelines on all topics relating to facility maintenance and cleaning of school buildings.

For more information on these topics, visit EPA's *IAQ TfS* Program Web site at www.epa.gov/iaq/schools, the *IAQ Design Tools for Schools* Program Web site at www.epa.gov/iaq/school design, and the Healthy School Environments Web Portal at www.epa.gov/schools.

EPA's Resources and Environmental Programs for Schools

EPA is a strong advocate for creating and maintaining healthy and safe school environments. For this reason, it has established several school-based voluntary programs to address a variety of environmental factors that schools encounter each day. These voluntary, school-based programs raise awareness for the importance of creating and maintaining healthy and safe indoor and outdoor school environments for students and staff. Many of these programs are specific to the operations and procedures of a school's Facility Department. Each program offers a wealth of free information and voluntary guidance on how schools can address the variety of environmental factors that affect school buildings, children, and staff. Each of these programs can easily be used on its own or in conjunction with others.

A well-rounded, practical school-based environmental program can yield overall improved performance of students, staff, and facilities. To make implementation easy, all guidance is voluntary, and all printable program materials are available free of charge from the IAQ Information Clearinghouse (1-800-438-4318 or iaqinfo@aol.com) or the National Service Center for Environmental Publications (1-800-490-9198 or ncepimal@one.net).

More details about each of these voluntary programs are provided below.

- **Healthy School Environments Web Portal**
- **Healthy School Environments Assessment Tool**
- **Clean School Bus USA**
- **ENERGY STAR® for K-12 Schools**
- ***Indoor Air Quality Design Tools for Schools***
- **Integrated Pest Management in Schools**
- **Lead in Drinking Water: Schools and Daycare Centers**
- **Radon in Schools**
- **Mercury in Schools**
- **Asbestos in Schools**
- **SunWise**

Healthy School Environments Web Portal

The Healthy School Environments Web Portal is a Web-based resource which EPA developed in 2003 as a "one stop shop" for links to resources and facts on topics related to environmental health in schools. The Portal provides school staff with information on managing environmental factors that can affect the safety of the school building and the health of its occupants. The Healthy School Environments Web Portal serves as a gateway to on-line resources to help facility managers, school administrators, architects, design engineers, school nurses, parents, teachers, and all school staff address a variety of environmental health issues. Topics addressed include chemical use and management, building design, construction, building renovation, energy efficiency, facility operations and maintenance, legislation and regulation, outdoor air pollution, portable classrooms, waste reduction, and drinking water.

For additional information on the above topics and more, visit www.epa.gov/schools.

Healthy School Environments Assessment Tool

The Healthy School Environments Assessment Tool (Healthy SEAT) is a no-cost comprehensive resource that school districts can use to evaluate and manage their facilities for key environmental, safety, and health issues. This tool includes fully customizable checklists to help school district level staff conduct self-assessments and database software that allows schools to manage all aspects of their assessment programs. In addition to powerful software that can be used by districts to track any facility issue it chooses, on a school by school basis, EPA has also included critical elements of all its regulatory and voluntary programs for schools, as well as Web links to more detailed information.

For more information and to download the Healthy SEAT, visit www.epa.gov/schools.

Clean School Bus USA

EPA launched the Clean School Bus USA Program in 2003 to address rising concerns over the condition of America's aging school bus fleet and the health effects on children resulting from exposure to diesel exhaust from idling school buses. Since its inception, Clean School Bus USA has experienced many successes, and EPA has provided grants to school districts across the country to fund the replacement of old school buses with new buses that use cleaner fuels.

Did you know that 24 million children ride a school bus each day, and students spend an average of more than one hour on a school bus each day? Traditionally, school buses have used diesel fuel. Pollution from diesel-fueled vehicles has health implications for everyone, especially children. Reports have identified a strong correlation between exposure to diesel exhaust and respiratory symptoms similar to asthma (e.g., allergies, wheezing, cough, labored breathing). Noting these facts, among others, EPA launched the Clean School Bus USA Program in April 2003.

Clean School Bus USA is the newest of EPA's voluntary school-based programs. In partnership with national business, education, transportation, and public health organizations, EPA aims to promote clean and safe school transportation for children to ensure that school buses remain one of the safest ways for children to travel to and from school. Among EPA's goals for Clean School Bus USA are:

- Reduce children's exposure to diesel exhaust that enters school buildings.
- Reduce pollution from school buses.
- Encourage schools to implement "anti-idling" policies and practices that will eliminate unnecessary exposure to diesel exhaust in the school yard.
- Upgrade or "retrofit" older buses with better emissions control technologies.
- Fuel buses with cleaner fuels.
- Replace the oldest buses in the U.S. school bus fleet with new, less polluting buses.

To support EPA's efforts to reduce pollution from school buses, Congress allocated $5 million for a cost-shared grant program designed to assist school districts in upgrading their bus fleets. For the first grant competition in 2003, EPA received over 120 applications requesting nearly $60 million in funds. Seventeen demonstration projects were selected for funding. The projects will demonstrate a variety of approaches to reducing pollution from school buses. These demonstrations will involve about 4,000 buses and remove over 200,000 pounds of diesel particulate matter from the air over the next ten years.

Building on the 2003 Clean School Bus USA demonstration grants program, Congress again allocated $5 million for school bus retrofit and replacement grants in 2004. EPA selected 20 projects for funding a diverse set of demonstrations around the nation.

In Fiscal Year 2005, Congress allocated $7.5 million for the Clean School Bus USA cost-shared grant program. EPA received over 170 applications requesting nearly $50 million in grant funding.

For more information on the Clean School Bus USA Program, visit the Program Web site at www.epa.gov/cleanschoolbus/.

ENERGY STAR® for K-12 Schools

EPA's ENERGY STAR Program for K-12 schools offers suggestions for simple building improvements, which can reduce annual energy expenses by 25 to 30 percent. EPA's ENERGY STAR Web site offers a variety of tools and information that can help schools check their buildings' current energy performance and benchmark their buildings over time to monitor energy use and savings.

EPA's voluntary ENERGY STAR Program offers information for schools on how to incorporate building improvements that will help to reduce energy costs. Did you know that the annual energy bill for America's primary and secondary schools is an astounding $6 billion? By making simple building improvements – replacing outdated, old, and poorly functioning building equipment, and improving operations and management practices – schools can reduce annual energy expenses by 25 to 30 percent. EPA' ENERGY STAR Program for schools offers the only national rating system for measuring energy performance, prioritizing energy upgrades, and undergoing building improvements to improve energy efficiency.

EPA's ENERGY STAR Web site offers a variety of valuable on-line tools and information resources, such as the Portfolio Manager, Energy Benchmarking, and online presentations. Schools can use these resources to improve building management practices, incorporate energy upgrades, and reduce long-term energy costs.

For more information on the ENERGY STAR for K-12 Schools Program, please visit EPA's Program Web site at www.energystar.gov and click on the "Education" link under "Business Improvement."

Indoor Air Quality Design Tools for Schools

EPA introduced *Indoor Air Quality Design Tools for Schools* (*IAQ DTfS*) as a complement to the *IAQ TfS* Program. *IAQ DTfS* is voluntary Web-based guidance for schools on how to design healthy, high performing schools from the ground up and incorporate IAQ practices during building maintenance and renovations. *IAQ DTfS* offers free, voluntary guidance for schools on effective design, construction, renovation, operations, and maintenance of school facilities targeted to school administrators, building design teams, construction supervisors, and facility managers.

Key topics addressed on the *IAQ DTfS* Web site include: pre-design, HVAC systems and maintenance, controlling pollutants and pollutant sources, moisture (and mold) control, construction, building commissioning, building operations and maintenance, pest control, renovation and repair, and portable classrooms. EPA offers this information to promote the importance of high performance schools for maintaining building environments with good IAQ. The site offers useful guidance on selecting and purchasing building products that can improve the indoor environmental quality of the school. Information available on the Program Web site strengthens the links between environmental factors and student and staff health and performance.

For more information, visit the IAQ Design Tools for Schools Web site at www.epa.gov/iaq/schooldesign.

Integrated Pest Management in Schools

EPA's Integrated Pest Management (IPM) Program for schools offers voluntary guidance and tips for how schools can incorporate "green" building maintenance practices and environmentally sensitive, lowest-impact chemical control of pests in the school environment to reduce the use of common toxic pesticides.

Through the IPM in Schools Program, EPA offers a wealth of free information to help schools incorporate cultural, mechanical, and lowest-impact chemical control technologies and environmentally sensitive approaches to managing pests in schools. By limiting the use of toxic cleaning and maintenance products, schools can reduce the potential for building occupants to have adverse allergic reactions to toxic chemical exposure, specifically to pesticides utilized by schools.

Common IPM practices that EPA advocates for schools include:

- Place vegetation, shrubs, and wood mulch at least one foot from structures.
- Fill or eliminate cracks and crevices in walls, floors, and pavement.
- Empty and clean lockers and desks at least twice a year.
- Clean food-contaminated dishes, utensils, and surfaces each day.
- Clean garbage cans and dumpsters regularly.
- Apply fertilizer several times per year, rather than in one heavy application.
- If the use of pesticides is necessary, use spot treatments instead of area-wide applications.

Several print and on-line resources are available from EPA and other organizations, such as the National Pesticide Information Center, on how to incorporate IPM practices in routine school maintenance schedules.

For more information, visit EPA's IPM Program Web site at www.epa.gov/pesticides/ipm.

Lead in Drinking Water: Schools and Daycare Centers

EPA developed the Lead in Drinking Water Program for Schools and Day Care Centers to educate schools on facts regarding lead in drinking water and potential health impacts for children. Young children and infants whose main diets consist of liquid can get 40 to 60 percent of their lead exposure through water. EPA encourages schools and day care centers to test water for lead concentration at all fixtures used for drinking, cooking lunch, and preparing juice or formula. This will help to reduce the potential for children's exposure to lead.

For more information on EPA's Lead in Drinking Water Program for Schools and Day Care Centers, visit www.epa.gov/safewater/lcrmr/pdfs/report_lcmr_schoolssummary.pdf.

Radon in Schools

EPA introduced the Radon in Schools Voluntary Program in an effort to communicate facts on radon, to raise awareness of the dangers of radon exposure, and to encourage schools to test for radon. A nationwide survey showed that nearly one in five schools in the U.S. had at least one school room with a radon level above EPA's recommended action level of 4 picoCuries per liter (4 pCi/L). EPA estimates that more than 70,000 school rooms have high short-term radon levels and encourages students, teachers, and parents to be aware of radon as a potential problem in their schools. To date, approximately twenty percent of schools in the U.S. have tested for radon. EPA encourages schools to contact their state's radon office for additional technical assistance and guidance about how to lower radon levels in schools.

To promote testing, EPA established three easy steps for schools to test for radon:

- Conduct initial testing in all frequently used rooms at or below ground level. These areas of a school building are at highest risk for elevated radon levels because radon is a soil gas that moves through the ground and can seep into a building through cracks and other holes in the foundation.
- Conduct follow-up testing in rooms with radon levels of 4 pCi/L or higher.
- Take action to reduce elevated radon levels.

The document "Radon in Schools (2nd Ed.)" and your state radon office offer tips and action items for reducing radon levels in schools, homes, and other buildings at risk for high levels of radon.

For more information on EPA's Radon in Schools Program, visit www.epa.gov/iaq/radon/pubs/schoolrn.html.

Mercury in Schools

The Mercury in Schools Program offers information and guidance for school administrators, faculty, staff, local health jurisdictions, and parent groups on how to reduce the hazards of mercury exposure in schools. Mercury is used in many items commonly found in schools, such as thermometers, barometers, switches, thermostats, flow meters, lamps, and laboratory reagents in chemistry and science labs. Two major causes of mercury spills at schools are improper storage and mishandling of these items. EPA encourages schools to prevent spills by removing all mercury compounds and mercury-containing equipment and by discontinuing their use. The Program Web site offers a variety of resources, including information on state-based mercury programs for schools, EPA's Schools Chemical Cleanout Campaign (SC3), and school case studies.

For more information on EPA's Mercury in Schools Program, visit www.epa.gov/mercury/schools.htm.

Asbestos in Schools

The presence of asbestos in high-activity public buildings such as schools presents the opportunity for inadvertent disturbance and potential for exposure. Consequently, EPA created a Web resource addressing asbestos in schools. This resource contains information on the Asbestos

Hazard Emergency Response Act (AHERA), which requires public and private non-profit primary and secondary schools to inspect their buildings for asbestos-containing building materials. Additional resources include a fact sheet on asbestos management in schools, a summary of health effects of asbestos, frequently asked questions about asbestos in schools, and useful links to other EPA and non-EPA resources.

To learn more, visit www.epa.gov/asbestos/asbestos_in schools.html.

SunWise

SunWise is a collaborative partnership between EPA, schools, and many other organizations committed to educating the public about the dangers of exposure to the sun. It is a nationwide program for grades K-8 that encourages schools to provide sun-safe infrastructure (including shade structures) and policies that promote sun protection. The Program brings together schools, communities, teachers, parents, health professionals, environmental groups, meteorologists, and educational organizations to raise awareness for sun safety. It offers sample activities and ideas for elementary and middle school teachers to promote sun safety practices at school and at home. These activities raise awareness of sun safety and the importance of protection from harmful UV rays.

Any U.S. elementary or middle school can participate in the program and can become a SunWise partner school by completing three simple tasks:

- Filling out the registration form on EPA's Program Web site;
- Completing the "Student Survey" before and after implementation of SunWise activities; and
- Adopting at least one supplemental SunWise school activity.

The SunWise Web site offers a wealth of ideas and suggestions for extra SunWise school activities such as cross-curricular classroom lessons, measuring UV levels and posting results on the school Web site or in the school building, enhancing school infrastructure with shade structures, and conducting community outreach, such as inviting guest speakers to talk to students about fun, sun safety practices. The Program Web site also offers a Tool Kit of resources and ideas for SunWise activities, an Internet Learning Site and UV database, and free educational materials (e.g., fact sheets, brochures, activity books, posters, newsletters) with facts on sun safe practices.

For more information on EPA's SunWise Program, visit www.epa.gov/sunwise.

Resource for Urban School Districts

The American Association of School Administration (AASA) Urban Resource Coalition Focuses on IAQ Efforts of Urban School Districts

The AASA has been intimately involved in indoor air quality issues since 1992 and has been a long time partner with EPA to educate schools about the effects of poor indoor air quality on children's health and continues to encourage the adoption of proactive indoor air quality management programs or similar to EPA's *IAQ TfS* among school administrators.

AASA recognizes that all schools need education and technical resources and support when addressing the growing issue of poor indoor air quality in schools, but this is particularly true of urban school districts. These school districts have higher numbers of impoverished or low-income families, and higher rates of children with asthma. Urban schools enroll 24% of all public school students, 35% of poor students, and 43% of minority students in the nation. As a result, the AASA Urban Resource Coalition (URC) was established in 2002.

The Urban Resource Coalition is comprised of urban school districts ranging in size from 4,000 school children to 740,000 school children. Its members are superintendents, assistant superintendents, and other administrators, facility managers, directors, and school health personnel. Annually, this coalition comes together to discuss the needs of their schools regarding indoor air quality including the barriers and successes to improving indoor air quality in schools, learn about and discuss resources such as the EPA's *IAQ TfS* Action Kit and discuss ways AASA can be a better IAQ resource to urban districts. This communication continues throughout the year with quarterly newsletters and continued exchange of resources and ideas.

Members of this coalition have produced exceptional projects as a result of their involvement ranging from asthma pilot programs to IAQ science projects in classrooms. Six of the twelve coalition members have received awards from EPA because of their great work and continue to receive recognition from other associations and their individual school districts.

Members of the Urban Resource Coalition include:

Bridgeport Public Schools, Bridgeport, CT; Cedar Rapids Community School District, Cedar Rapids, IA; Charlotte-Mecklenberg Schools, Charlotte, NC; Detroit Public Schools, Detroit, MI; East Valley School District 361, Spokane, WA; Los Angeles Unified School District, Los Angeles, CA; Memphis Public Schools, Memphis, TN; Norwich School District, Norwich, CT; Providence Public Schools, Providence, RI; Saint Louis Park School District, St. Louis Park, MN; Spokane School District 81, Spokane, WA; St. Joseph School District, St. Joseph, MO.

AASA welcomes the addition of any urban school district to join the URC. Just contact the project director, Ericka Plater Turner at eturner@aasa.org or 703-875-0731.

Table of Most Common Indoor Molds

Table of Frequency of Occurrence of Common Indoor Building Molds[2]			
Mold	**Percent of Samples**	**Mold**	**Percent of Samples**
Cladosporium sp.	16.67	*Ceratocystis sp.*	0.49
Cladosporium sphaerospermum.	16.57	*Aureobasidium pullulans*	0.49
Stachybotrys chartarum	16.37	*Peziza cerea*	0.49
Aspergillus sp.	06.02	*Aspergillus versicolor*	0.39
Penicillium sp.	03.85	*Unid. wood rot fungus*	0.39
Unidentified mold	03.85	*Mucor sp.*	0.39
Ulocladium sp.	03.06	*Cladosporium herbarum*	0.39
Cladosporium cladosporioides	02.47	*Chaetomium murorum*	0.30
Non-sporulating fungi	02.47	*Acrodictys sp.*	0.30
Chaetomium globosum	02.37	*Aspergillus niger*	0.30
Alternaria sp.	02.17	*Papalomyces*	0.30
Chaetomium sp.	01.97	*Cunninghamella blakesleana*	0.20
Ulocladium sp.	01.97	*Paecilomyces varioti*	0.20
Alternaria alternata	01.97	*Oidiodendron sp.*	0.20
Penicillium/Aspergillus sp.	01.28	*Memnoniella echinata*	0.20
Acremonium sp.	0.99	*Microascus triganosporus*	0.20
Chrysosporium sp.	0.89	*Dendriphiella sp.*	0.20
Dicyma olivacea	0.79	*Cladosporium oxysporium*	0.20
Gliomastix murorum	0.69	*Ulocladium botrytis*	0.20
Merulipoira incrassata	0.69	*Verticllium sp.*	0.20
Gliomastix sp.	0.59	*Trichoderma harzianum*	0.20
Phoma sp.	0.49	*Chaetomium piluliferum*	0.20
Ascotricha chartarum	0.20	*Bispora betulina*	0.20

Notes to Table

1. J. Haines, New York State Museum, multi-year survey of surface samples collected on adhesive tape and submitted to NY DOS by home owners or by health department officials. Personal communication to DJ Friedman. Arranged by percent of total samples analyzed. The contents of this web page are the opinion of the author and are subject to update pending further technical and professional review.

2. Warning: because most of the samples submitted to Dr. Haines were collected by people who were not expert at recognizing or even finding the most-problematic molds in buildings, there may be an over-reporting of the dark, easy-to-see molds such as the top three in this list, and an under-reporting of the often light, hard-to-see problematic molds such as *Aspergillus. sp.* and *Penicillium sp.*. In my own field work responding to client-detected mold concerns, in most cases where the occupant or owner has seen a "scary black mold" or a "toxic black mold" a more careful study of the building discloses that it is the previously un-detected *Aspergillus. sp.* and *Penicillium sp.* which were the mobile, airborne, and dominant problematic molds to which the occupants were actually exposed.

In addition, I have been using special methods to test fiberglass building insulation for *Penicillium/Aspergillus sp.* in areas where the insulation has been wet or where insulation has been exposed to active mold growth such as over a wet crawl space or a moldy basement. I have often found large reservoirs of these problem molds in building insulation, observing that the reservoir is releasing high levels of airborne mold spores. This mold contamination is discoverable by contextual inspection and special test methods, but it is not at all visible to the naked eye.

An exception to the speculation that these small, hard-to-see molds are the more serious problem in buildings is during amateur cleanup and demolition work without adequate containment measures. Demolition can cause molds which are not normally airborne, such as *Stachybotrys chartarum* to become widely dispersed in a building.

3. Some of the molds listed in this table, even though found indoors, are unlikely to be indicative of a growing mold reservoir of that genera/species. For example, I often find *Cladosporium herbarum* and certain *Basidiomycetes* such as *Ganoderma sp./G. applanatum/G. tsuge* in indoor air samples but I have not found these genera/species growing on building materials. Rather they enter in outdoor air.

In conclusion, this interesting table needs additional research with data provided by expert building investigators rather than self-collected data by individuals who spot first and sample first dark molds on building surfaces. Readers should see How to Look For Mold.

Which Mold Species are Most Common? Most Toxic?

Opinion as to the most common species varies. A chapter on indoor mycology in North America (*Building Mycology*, ch. 11) says the most common fungal genera found in houses (present in 10 to 100% of samples) are *Cladosporium, Penicillium, Alternaria, Streptomyces and Epicoccum*. Brian Flannigan, who gave a paper, "Guidelines for Evaluation of Airborne Microbial Contamination of Buildings," at the 1994 Saratoga Springs conference, says that the most common indoor molds are likely to be species of *Cladosporium, Penicillium, Aspergillus* and *Eurotium*. Fausta Gallo has identified *Aspergillus* and *Penicillium* as the most common species in libraries (1986, ICCROM).

Nominations for most toxic species also vary. Aspergillus fumigatus and Stachybotrys are two examples that Flannigan offers of moisture-loving toxic molds that can flourish indoors. He cites a Canadian guide on office buildings, which says that "Pathogenic fungi such as Aspergillus fumigatus, Histoplasma and Cryptococcus should not be present in significant numbers. The persistence of toxigenic molds such as Stachybotrys atra and Aspergillus versicolor in significant numbers requires investigation/action."

Jeffrey Cooper and J. Michael Phillips listed the following five species as most toxic in a recent paper: Aspergillus flavus, A. fumigatus, A. versicolor, Fusarium moniliforme, and Stachybotrys chartarum. They say, "The detection of any toxigenic fungi indoors is considered unacceptable from a human health risk perspective. The confirmed presence of [any of these five species] requires urgent risk management decisions by building owners." ("Assessment and Remediation of Toxigenic Fungal Contamination in Indoor Environments," First NSF International Conference on Indoor Air Health, May 3-5, 1999, Denver, CO)

Several authors have pointed out that each type of building (homes, schools, office buildings) tends to have its own set of typical mold species. This is probably because each building type typically has its own characteristic "amplifiers" or sources and conditions, such as mattress dust and humid bathrooms in homes, leaky roofs and defective plumbing in schools, and poorly maintained HVAC systems in office buildings.

The mold counts found on the weather page of many newspapers have little to do with the indoor exposure to toxic mold spores. Outdoor molds are not normally a threat to human health. Many of them live on plant leaves or in forest litter, and are not found in great concentration except in ooutdoor manmade facilities like compost areas, dumps, and sawmills.

HOW TO LOOK FOR MOLD - How to Find and Test for Mold in Buildings - Looking for Mold

Part 5 - Hidden Mold in Buildings

The fact that mold is "hidden" in buildings does not mean one cannot find it. We look by context: where do we see leak stains, or where do we see building practices most likely to have produced a hidden leak or moisture problem. Ice dam leaks in walls, hidden plumbing leaks, roof spillage by the foundation, are all common clues that often track to a wet building wall or ceiling cavity and from there to a hidden mold problem which may need to be addressed. This document describes how to find mold and test for mold in buildings, including how and where to collect mold samples using adhesive tape - an easy, inexpensive, low-tech but very effective mold testing method. This procedure helps identify the presence of or locate the probable sources of mold reservoirs in buildings, and helps decide which of these need more invasive, exhaustive inspection and testing.

HIDDEN MOLD in Buildings, Insulation Mold, and Other Hidden Mold Reservoirs in Buildings

In the photo at page top we see the results of a wall cut through drywall to expose wet moldy insulation, mold on the cavity side of drywall, and surprise! a leak in a pipe that the owner did not know was in her basement wall. However there was good evidence in the form of stains on the exposed side of this drywall. Look at the tan stain which is in the photo in the half-round shape directly above the wall cutout.

Don't try to investigate a building by dashing about with an axe cutting holes willy-nilly. That is an unnecessarily and inappropriately destructive approach to studying a property. But when building history, occupant complaints, or direct site observation of site and building conditions raise the level of probability of an important hidden leak or other damage, directed exploration, often with very modest means, can be very productive. Here are just a few examples:

- Pull off floor trim at the floor/wall juncture in basements on walls suspected of harboring leakage - look on the back of the trim and on the newly exposed drywall.
- Make test cuts in drywall in areas most-likely to have been wet
- Lift carpets to inspect carpet tack strips and carpet padding and carpet underside. (See the MOLDY CARPETS link at left.)

We have little confidence in and are reluctant to make random test cuts in buildings. Since water can take peculiar paths through hidden openings, such as wall plate holes drilled for pipes or electrical wiring or between single pairs of studs or ceiling or floor joists, cutting a hole that does not reveal a problem is no assurance at all that no hidden problems exist.

What makes more sense is to study the building carefully to decide on the building points *at most risk* of having been wet from leaks due to construction details or other site observations. That's where one would make a test cut.

Small amounts of mold can be removed simply by cleaning or removing infected materials, something most homeowners can handle -- but see the *Warning Notice* at the end of this article. Some mold species can make you sick.

Mold in your house might be only a cosmetic concern. "Bluestain" or *Ceratocystis/Ophistoma* is common on framing lumber and we often find it in attics on the under side of roof sheathing. Unless it's in finished portions of living space, no particular action needed.

Cosmetic Molds

Recent news articles have made some people terrified at the mere mention of "*Stachybotrys*." Actually it is common to find *Stachybotrys chartarum* in small amounts in houses where there has been prolonged leakage or water entry. It's a toxic mold that should be removed. Don't assume that anything black on the wall is a highly toxic mold. Other common species look black but may be of low or no toxicity. For example, *Chaetomium globosum* has been reported to be allergenic rather than toxic. *Cladosporium sphaerospermum* is often found growing indoors on bathroom tile or refrigerator gaskets. It's a member of the most common mold family, *Cladosporium*, the "universal fungus."

Cladosporium indoor species

Cladosporium sphaerospermum

You cannot determine the mold genera and species just by looking at it on the wall, and please skip those do-it-yourself mold test kits. The methods the kits use are fundamentally inaccurate and in a few cases so are their laboratories. For small mold problems, spend your money on some soap and water instead. For larger problems hire an expert to survey your home, or send your own mold sample to a competent testing laboratory. The services of an experienced mycologist or aerobiologist are necessary to know what you've got.

Memnoniella echinata indoors

Another black mold, *Memnoniella echinata* is particularly toxic and irritating. It's considered a member of the *Stachybotrys* family but unlike *Stachybotrys chartarum*, a sticky spore that tends to stay in its place, *M. echinata* is easily airborne and I often find it in the air when it’s growing in the building. It’s more of a problem than its famous brother. A small amount of mold on the visible side of a wall may be a clue that there is a much bigger problem inside the wall cavity.

Aspergillus molds indoors can be difficult to see

Other mold species are light in color or nearly invisible when growing on an interior surface unless you look carefully. This desk sat in a wet basement for only two months yet it was rapidly covered with a toxic mold, *Aspergillus niger*. *A. niger* spores are tiny and are easily made airborne by the smallest disturbance.

I find as much or more *Penicillium/Aspergillus* in houses than *Stachybotrys*, but these light green, gray or tan mold colonies are more difficult to see if you don't know how to look. To check more carefully and thus more successfully for mold, shine your flashlight along the wall surface in an area that has been damp or wet. Don't shine it right at the wall or you won't see much. Look where things have been wet or damp, regardless of whether it was a single event (washer flood) or one that happens at every rainstorm.

Keep in mind that different molds like different moisture, temperature, and food. One reason that *S. chartarum* has been "over-reported" as a problem in some studies is that the field "experts" didn't look for lighter molds, and maybe they didn't even carry a flash light. The photo here shows three tape samples being taken from different heights on a laundry room wall. Three different mold species were found, one in each area. Only the lowest black mold was obvious.

Other Places to Look for Hidden Mold

There are many places to look for mold growth. Here are a few others that you might not have considered: under carpets that have been wet - check for moldy tack strips; previously wet cardboard boxes; at ceiling penetrations like 120-V smoke detectors; at the top of poorly-insulated exterior walls; behind wallpaper below windows which had a one-time or recurrent leak (this is my daughter’s house!). Don't forget to clean your refrigerator, including gaskets, coils, and evaporator tray. Finally, take a careful look at your air conditioner as well as any heating or cooling air handlers and duct work. Check especially downstream of the air handler on cooling systems since condensation there may promote mold growth.

Mold Safety Warnings for Do-It-Yourself'ers

Warning notice

Guidelines defining what's a "large amount" of mold and what's reasonable for a homeowner to handle have been published by several states including New York and California. People who are allergic, asthmatic, infant, elderly, immune-impaired, etc., should not disturb mold and should not be in the area where mold remediation is being performed. Consult with your doctor, health department or other professional before tackling this job yourself.

About the Author

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Daniel Friedman is a mold/indoor air quality investigator and home inspector as well as a professional writer in Poughkeepsie, New York. He is a member of the American Industrial Hygiene Association and the American Society of Home Inspectors.

Indoor Air Quality Tools for Schools

Action Kit

Indoor Air Quality Tools for Schools

IAQ Coordinator's Guide

- 1 - 5 IAQ Basics
- 6 - 9 IAQ Management Plan
- 10 - 13 Resolving IAQ Problems
- A - J Appendices

Action Kit Overview

- IAQ Coordinator needed
- Less expense and effort to prevent problems than resolve
- IAQ problems can be prevented by educating staff and students about factors that create them

1

Importance

- Indoor pollutants 2 - 5 times higher than outdoor
- People spend 90% of their time indoors

2

Importance

- Decrease health complaints
  - Cough
  - Eye irritation
  - Headache
  - Asthma episodes
  - Allergic reactions
  - Severe asthma attacks
  - Legionnaire's disease
  - Carbon monoxide poisoning

2

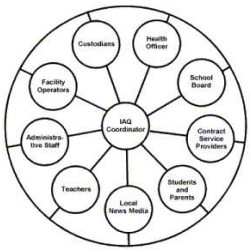
Importance

- Reduce spread of infectious disease
- Produce favorable learning environment
- Increase productivity
- Reduce absenteeism
- Better maintenance of equipment

2

IAQ Coordinator

- Team leader



3

IAQ Coordinator

- Implements the IAQ Management Plan (Sections 6 - 9)
- Prepares and coordinates emergency response (Sections 16 - 13)

3

IAQ Coordinator

- Central information location
  - Complaints
  - Information
    - Renovation projects
    - HVAC activities
    - Chemical use

3

Team Members

- Faculty
  - Art, science, etc. classes generate sources
- Staff
  - Printing/office equipment generates sources
  - Temperature/humidity controls
- HVAC personnel

4

Team Members

- Custodian/building maintenance
  - Dust*
  - Chemical use*
- Health officer/school nurse/occupational medicine
  - Identify complainants
  - Provide medical advise to exposed persons*

4

Team Members

- Administration
  - Budget, space, equipment decisions
- Contract service providers
  - Pesticide application, roofing, renovation, housekeeping, etc.
  - Involve Contracts/ Purchasing*
- Students/parents

4

Team Members

- Local news media
  - Distribute information
  - Minimize “bad” press

4

Minimum Team Members*

- Safety/IAQ Coordinator
- HVAC
  - Engineer
  - Maintenance
- Supervisor of affected area
- Occupational medicine

Understanding IAQ

- Sources
  - Inside, outside, or from mechanical system
  - Can vary by time and location
  - Appendix E lists by contaminant and describes sources

5

Sources*

- Occupants
  - CO_2
  - Bioaerosols
  - Heat
  - VOCs
    - Hairspray
    - Dry-cleaning solvents
    - Perfume

Sources*

- Standing water/floods
  - Mold
  - Bacteria
- Combustion
  - CO
  - CO_2
  - NO_X (diesel)
  - Particulates
  - Heat

Sources*

- Office machines
  - Heat
  - Ozone
  - Particulates
  - Noise

Sources*

- Chemical use
  - Cleaning solvents/detergents
  - Adhesives
  - Lab chemicals
  - Pesticides
  - Markers

Sources*

- Renovation/construction
  - Paint
  - Thinners
  - Lacquers
  - Adhesives
  - Dust
  - Asbestos
  - CO
  - Mold
  - Noise

Sources*

- Building materials
  - Formaldehyde
  - VOCs
  - Carpet
  - Carpet adhesives
  - Light ballasts
  - Luan

Sources*

- Miscellaneous
  - Dry drain traps
  - Building exhausts
    - Sewer
    - Fume hoods
    - Combustion
  - Dumpsters
  - Plants
    - Pesticides
    - Mold

Sources*

- Miscellaneous
  - Pollen
  - Food
    - Cooking odors
    - Brought by employees
  - Lead-acid batteries

Understanding IAQ

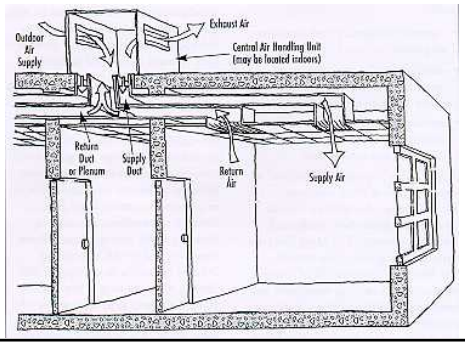
- HVAC system
  - Takes in fresh air
  - Mixes with return air
  - Filters
  - Tempers
    - Temperature
    - Humidity
  - Distributes
- Video

Understanding IAQ

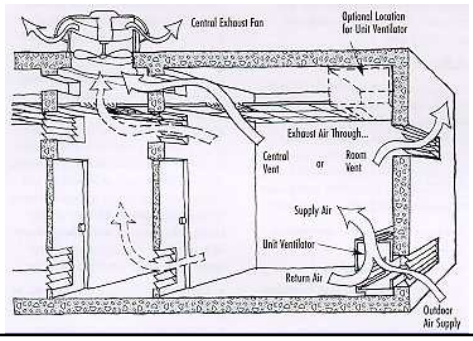
- HVAC system
  - Central air
  - Unit ventilator (fan coil unit)

5

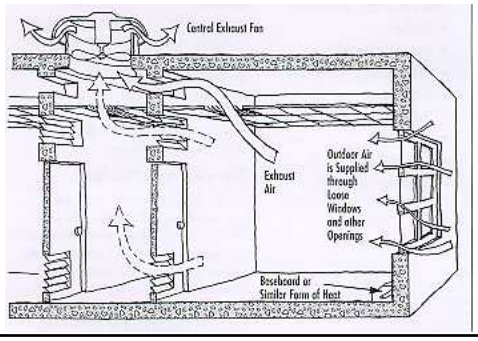
IAQ Backgrounder (4)



IAQ Backgrounder (3)



IAQ Backgrounder (5)



Understanding IAQ

- Thermal comfort
  - Temperature
  - Humidity

Thermal Comfort (11)

Relative Humidity	Winter Temperature	Summer Temperature
30%	68.5°F - 75.5°F	74.0°F - 80.0°F
40%	68.0°F - 75.0°F	73.5°F - 80.0°F
50%	68.0°F - 74.5°F	73.0°F - 79.0°F
60%	67.5°F - 74.0°F	73.0°F - 78.5°F

Recommendations apply for persons clothed in typical summer and winter clothing, at light, mainly sedentary activity.
Source: Adopted from ASHRAE Standard 55-1992, Thermal Environmental Conditions for Human Occupancy.

Understanding IAQ

- Ventilation for occupant needs
  - ASHRAE Standard 62
    - Contaminant concentrations
    - Fresh air supply

Fresh Air Ventilation Recommendations (12)

Type of Room	CFM per Person
Classroom	15
Music Rooms	15
Libraries	15
Auditoriums	15
Spectator Sport Areas	15
Playing Floors	20
Office Space	20
Conference Rooms	20
Smoking Lounges	60
Cafeteria	20
Kitchen (cooking)	15

Understanding IAQ

- Pollutant (and fresh air) pathways
  - Air flow
  - Positive/negative pressure
  - Blockage
    - Covered ducts
    - Cubicles

Understanding IAQ

- Occupants
  - Susceptibility
    - Allergy/asthma
    - Chemical sensitivity
    - Respiratory disease
    - Suppressed immune system
    - Contact lenses
    - Heart disease (CO)
    - Children (tobacco smoke)

Understanding IAQ

- Complaints
  - Headache
  - Fatigue
  - Shortness of breath
  - Sinus congestion
  - Coughing
  - Sneezing
  - Eye/nose/throat/skin irritation
  - Dizziness
  - Nausea

Understanding IAQ

- Causes other than IAQ
  - Thermal comfort (hot causes fatigue)
  - Lighting/glare (causes headaches)
  - Job stress
  - Illness clusters (get health department and/or medical* advise)

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Other Causes*

- Do not dismiss because YOU think there is no IAQ problem without fully investigating
- Act of investigating may mitigate problem
- Investigation may uncover “root” cause, which should be discussed with supervisor

IAQ Management Plan

- Fix any existing IAQ problems
- Instill IAQ awareness for prevention
- Resolve IAQ issues as they occur

6

IAQ Management Plan

- Select IAQ Coordinator
- Become familiar with kit

7

IAQ Management Plan

- Gain top administrative support
  - Note to School Officials (page i of guide)
  - IAQ Backgrounder
  - Sections 2 , 6 , 9
  - Supposed to be little or no impact on school budget/ time resources (except for ventilation checklist)

7

IAQ Management Plan

- Obtain information on radon*
- Obtain information on integrated pest mgmt.
  - Reduce use of chemicals
  - EPA 735-F-93-012
- Obtain information on lead*
- IAQ Checklist interval
  - 1-2 times/year

7

IAQ Management Plan

- Plan for emergency response
- Inform appropriate committees and groups
  - PTA
  - Safety Committee
  - Staff/Faculty Senate*
  - Employee Liaison*

7

IAQ Management Plan

- Establish written policies as needed
  - Smoking
  - Pest control
  - Ventilation system operation
  - Painting
  - Spill response*
  - Chemical use*

(Checklist on page 5-6 of IAQ Coordinator's Forms tab)

7

IAQ Management Plan

- Assess Current Status
  - Start the Checklists Log (page 9 of IAQ Coordinator's Forms tab)
  - Decide who will get Action Packets (checklists + info)
    - Teachers
    - Staff
    - Facility operators
    - Custodians
    - Health officers
  - Log tracks checklist returns

8

IAQ Management Plan

- Distribute packets
- Receive and summarize the checklists
- Perform a walkthrough
  - Look for problem areas based on checklist responses

IAQ Management Plan

- Walkthrough
  - Cleanliness
  - Mold
  - Chemical use and storage
  - Dirty air filters
  - Blocked air vents
  - Odors
  - Temperature
  - Drafts
  - Airflow

IAQ Management Plan

- Walkthrough
  - Listen to occupants
  - Look at special use areas
    - Food preparation
    - Labs/science rooms
    - Art rooms
    - Industrial arts
    - Smoking lounges
    - Shops*

IAQ Management Plan

- Set repair and upgrade priorities
- Gain consensus and approval
- Distribute status report
- Perform repairs and upgrades
- Conduct follow-up inspections

8

Choices*

- Full IAQ program as defined by this guide
- Selected checklists for preventive actions
- Respond to complaints

Preventive Actions*

- Administrative support
- Ventilation Checklist
- Building Maintenance Checklist
- Renovations and Repairs Checklist

Ventilation Checklist

- Outdoor air intakes
  - Be sure you have one*
  - Unobstructed
  - Clear of nearby pollutant sources
  - Air is entering (dampers open*)

Ventilation Checklist

- Cleanliness
  - Filters
    - Clean
    - Fit
    - Installed for proper direction of airflow

Ventilation Checklist

- Cleanliness
  - Condensate drip pans
  - Heating and cooling coils
  - Air handling unit/duct interiors
  - Mechanical room

Ventilation Checklist

- Ventilation controls
  - Timer appropriate
  - Pneumatic control system, outdoor air damper, water coil freeze protection etc. function properly
  - Fans operate continuously even when temperature is satisfied

Ventilation Checklist

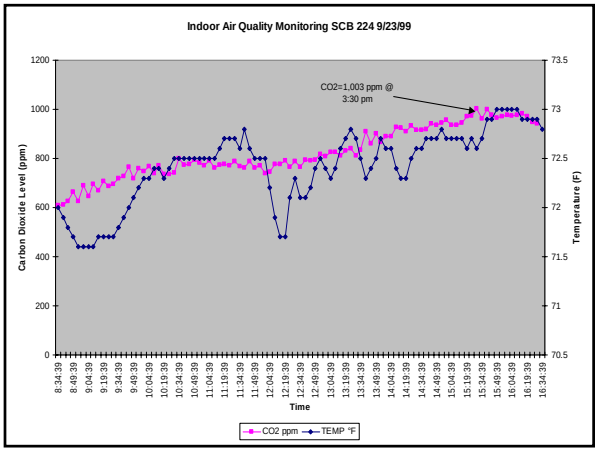
- Air distribution
  - Not obstructed by blocked vents or cubicles
  - Air flow direction
    - less contaminated to more contaminated

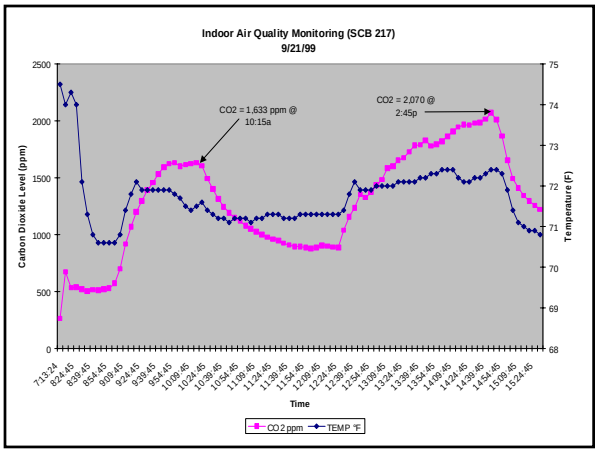
Ventilation Checklist

- Exhaust
  - Fans are operating
  - Local exhaust (hoods, snorkels) adequate to remove source contaminants

Ventilation Checklist

- Outdoor air
  - Quality
  - Quantity
    - CFM per person
    - CO_2 measurements





Building Maintenance Checklist

- Low odor/hazard chemicals used
  - High odor
    - Use after hours or late in day
    - Increase ventilation
- Dust control

Building Maintenance Checklist

- Floor cleaning
  - chemicals
  - dust from vacuum
- Drain traps
- Combustion sources
- Pest control

Resolving Problems: Communication

- Be honest
- Respect your audience
- Avoid technical language
- Listen
- Emphasize action to be taken
- Encourage feedback

9

Communication

- Be prepared for questions
- Be responsive
- Combat rumors with facts
- Tell people what you can and cannot do

9

Resolving Problems

- Be prompt
- Is it an emergency? (CO, spill, biological)
  - Evacuate affected areas
  - Get expert(s)
  - Provide medical evaluation/ treatment as necessary*
  - Ventilate/ensure no hazard before reoccupancy*

10

Diagnosing Problems

- Problem solving checklist (page 11 of IAQ Coordinator's Forms tab)
- Problem solving wheel

11

Diagnosing Problems*

- Emergency?
- Evaluate symptoms/complaints
- Evaluate potential sources
- Evaluate HVAC

Solving Problems

- Source management
  - Removal
    - Mold (and water intrusion!)
    - Engine exhaust
    - Animal Dander
  - Substitute less hazardous
  - Local exhaust of point sources

12

Solving Problems

- Adequate ventilation
- Exposure control
  - Schedule
  - Ventilate
  - Relocate
- Air cleaning (no ozone generators!!)
- Education

12

Should I Sample?

- No standards for “safe” levels – response to mold varies widely
- Mold is always present
- Counts do not identify the source
- Spore counts vary widely throughout the day, the season, and by occupant activity
- Counts are only a snapshot and can give false positives and false negatives

Finding Hidden Mold

- Water = Mold and Mold = Water
- Find the water to find the mold
- Room Climate and Micro-climates
- Find out the history of the building
- Interview occupants:
  - Symptoms
  - Timing

Where to Look?

- High Spots: roof, eaves, vents, flashing
- Low spots: seepage, standing water,
- Holes: doors, windows,
- Plumbing: pipes, vents
- Cold spots: exterior walls, AC ducts
- Mold food: paper, gypsum, particle board, lumber, glue,

More Places:

- Behind cabinets, mirrors, bookcases
- Under sinks, toilets
- Behind wallpaper
- Under carpets or flooring
- Inside of areas of obvious water source

Going Deeper

- Moisture Meters
- Minor disassembly:
  - Carpeting
  - Baseboard
  - Ducts
  - Ceiling tiles

- Wall cuts:
  - When water is likely
  - Possible “detoured” path
  - Random is hit-or-miss