FINAL REPORT OF THE

MONTGOMERY COUNTY PUBLIC SCHOOLS
INDOOR AIR QUALITY PROCESS ACTION TEAM

March 4, 1998

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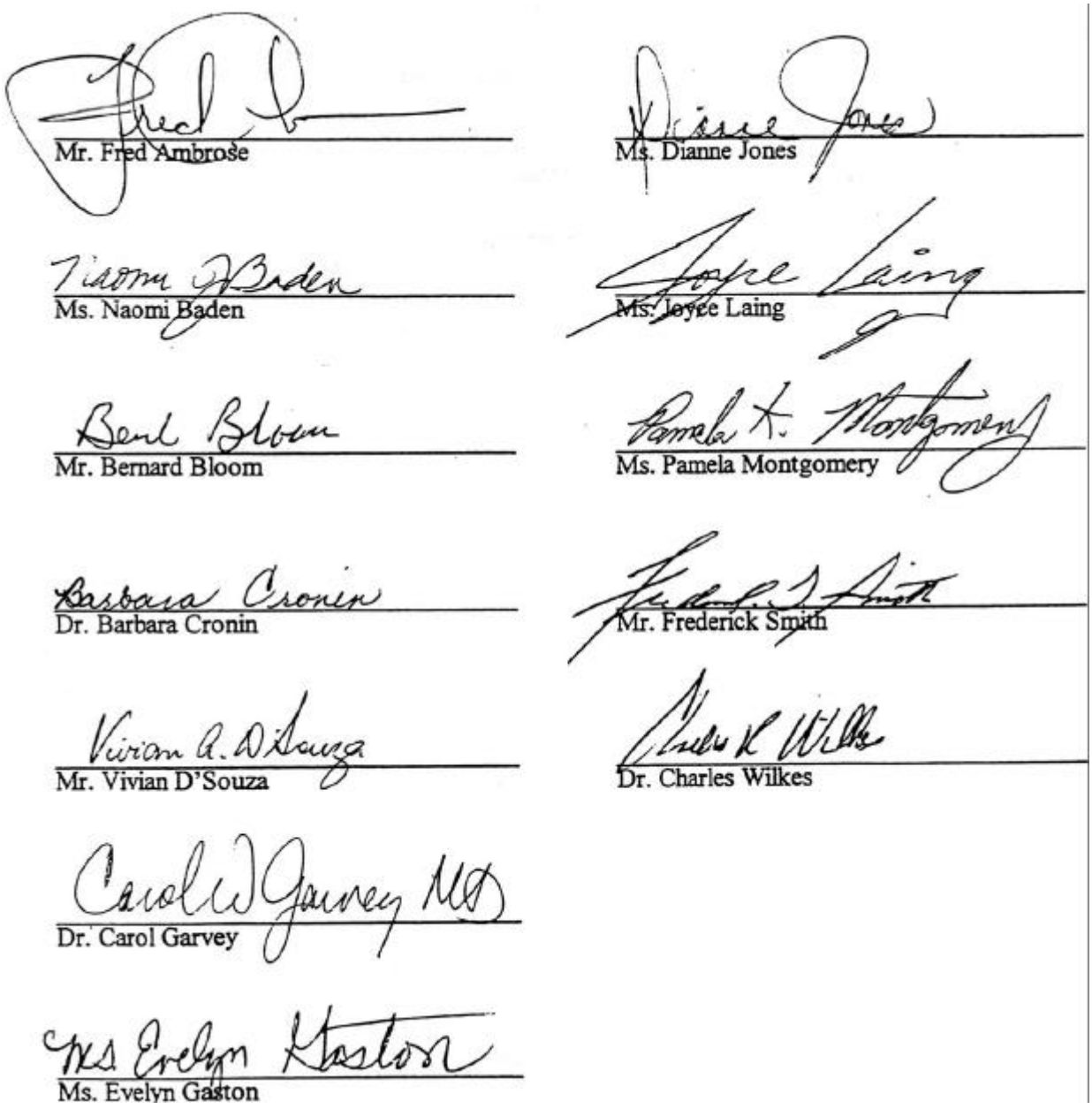
Submitted to David Fischer, Associate Superintendent for Supportive Services by the Indoor Air Quality Process Action Team.



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SEIU Local 500, MCCSSE, strongly objects to any plan for addressing IAQ which suggests that the problems can be resolved by directing building service or maintenance employees to perform particular tasks. Our position is that the problems cannot be addressed unless both staffing levels and training are increased for building services and maintenance, and expectations regarding other building services and maintenance work are adjusted. With these essential steps, the report becomes feasible and we would support it.

Montgomery County Public School

Indoor Air Quality Process Action Team Report

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Executive Summary

In recent years, indoor air quality (IAQ) problems occupied an increasing amount of parent, staff, and MCPS management attention. At the same time, communities have raised their expectations and concerns about the effectiveness of MCPS' procedures for addressing indoor air quality concerns. Within the past three years, approximately half of the schools in the county filed indoor air quality complaints with the MCPS Safety and Environmental Health Unit (SEHU). In FY 97, this Unit carried out approximately 125 complaint investigations involving approximately 250 site visits, and (together with other divisions of Facilities Management) issued thousands of work orders to repair equipment and facilities in order to improve indoor air quality. At any one time, there have been ten to twelve schools on the unit's high priority list.

Poor indoor air quality in schools is a problem for everyone because it can inhibit students' ability to learn and staffs' ability to work productively, and, for respiratory-impaired individuals, poor IAQ can trigger asthmatic attacks that lead to lost class or teaching time, impaired breathing, emergency room visits, hospitalizations, and even death.

In August 1997 the MCPS Associate Superintendent for Supportive Services, Mr. David Fischer, convened the Indoor Air Quality Process Action Team (IAQ PAT) with the task of looking "at broader issues as it relates to indoor air quality and to develop a consistent, proactive, countywide strategy in the school system." After six months of extensive research and deliberations, the team has concluded that the reasons for the current indoor air quality problems are systemic and have significant historical roots in the way school buildings have been designed and maintained in the past, and that an entirely new approach to the management of indoor air quality is needed.

The team has arrived at over fifty specific recommendations (presented in this report) for improving air quality in our schools, preventing future IAQ problems, and improving MCPS' ability to effectively, efficiently and candidly manage and mitigate IAQ complaints and problems that arise.

We highlight the most important of our recommendations here. The PAT concludes that the MCPS should adopt a clear vision for its IAQ program. Therefore, we recommend a statement of indoor air quality goals and organizing principles to guide MCPS' development of a coherent IAQ program. This goal is:

> *To achieve, maintain, and where necessary, to restore an indoor air quality environment in which everyone in a Montgomery County Public Schools (MCPS) facility can perform the necessary tasks of learning, teaching, administering, and sustaining facilities in a safe and healthy manner.*

The key to improving IAQ in MCPS schools is to reduce the incidence of new problems via preventive measures, rather than to continue its piecemeal problem response.

One of our recommendations is that MCPS should develop a plan, by July 31, 1998 for implementing each recommendation and then should present it to the public for feedback. MCPS should then retain an outside environmental auditor to ensure compliance with the indoor air quality improvement plan.

The primary means for preventing new problems is for MCPS to develop a school-based building maintenance plan (BMP) for each school in the county. For the last fifteen years, there has been little to no money spent on preventive maintenance of elementary or middle school unit ventilators, high school air handling units, and other mechanical equipment essential to providing clean air to our classrooms. Dirty unit ventilator internal surfaces are often fouled with mold populations. Apparently some units have never been cleaned; others have not been cleaned or maintained in years.

Partly this is due to increased demands on a continually reduced Maintenance Division staff. Since 1988, the total floor area in MCPS to be maintained has increased by 34%, yet the number of maintenance personnel has decreased by 15%. Similar reductions have affected the school-based building service workers. Also, the training of maintenance personnel has not been adequate. There is no organized knowledge of how each class of equipment is supposed to operate or function, nor are there documented records of when such equipment has been inspected, cleaned, and repaired.

The PAT recommends that the school-based building maintenance plans become the centerpiece of proactive school building maintenance. MCPS must establish formal training programs for plant operation and maintenance workers so they can be held to performance standards, and must create a Division of Maintenance team whose sole task is to inspect and repair unit ventilators. Furthermore, MCPS should take inventory of all ventilation equipment, and should establish and share a database of components, their current replaceablility, and their original design capabilities. MCPS should also hold an independent annual review at each school of progress towards implementing its BMP and post those results at the school.

In addition to proactive maintenance, it is imperative that all new and renovated buildings be built to code; designed to reflect realistic use forecasts; commissioned to demonstrate that the design requirements have been met; and use technologies that are not problematic from an IAQ perspective. Currently, this is not the case. For example, the Montgomery County building codes state that ventilation systems must supply 15 cubic feet per minute (cfm) of outside air per student in each classroom. The designs must accommodate a minimum of 45 students in each 900 sq. ft. room unless an alternative lower occupant load is proven by statistical data. However, the MCPS design guidance document (January 1997) requires that their contractor design "be based on an actual average occupancy of 25 persons at 15 cfm per occupant." This statement is in violation of current building codes, and would result in an inadequate design for occupant levels commonly found in current MCPS classrooms. All indoor air environments should meet minimum fresh-air ventilation requirements such that the levels of carbon dioxide (CO_2) in the classrooms remain under 1000 ppm (the threshold level identified by NIOSH over which occupants often complain of headaches, fatigue, stuffiness, and upper respiratory tract irritations).

Furthermore, buildings are not always properly checked to determine whether new construction or renovation has been done correctly, sometimes requiring MCPS to fix problems

resulting from poor construction practices by their contractor. For example, in one school a ventilation duct abutted a brick wall and resumed on the other side. Because contractor work was not checked out, this problem was not discovered until several years after the building was renovated. Consequently, MCPS had to pay for corrective actions rather than the contractor.

Moreover, most new HVAC systems installed in MCPS new or renovated schools are based on variable air volume technology. These systems have been shown not to be consistently able to control moisture and carbon dioxide levels, and consequently MCPS should reevaluate and justify the installation of these systems in new school buildings.

Most of the current MCPS school buildings were designed and constructed to ventilation and occupancy standards that are less than today's standards (5 cfm per person in the mid 1970s versus 15 cfm per person as of 1995). For this reason, they must be made to operate to the best of their capacities to even get close to attaining CO_2 levels lower than 1000 ppm.

Compounding this problem of poor ventilation, and subsequent elevated CO_2 levels are three other factors. The first factor is overcrowding in classrooms: more people create more CO_2. Classrooms now contain more students than they were designed to support. The second factor results from certain Energy Management functions that unintentionally deprive students and teachers of adequate indoor air quality. School ventilation systems units are turned off after school hours, not allowing the removal of air contaminants that have built up during the school day by the next morning. The third contributing factor is the lack of air balance in many MCPS buildings, sometimes attributable to exhaust fans being turned off or to broken parts, or uncleanness components. Air imbalances undercut effectiveness of ventilation equipment.

MCPS also needs to ensure management commitment to preventing and responding to indoor air quality problems. With regard to problem response, MCPS needs to restructure its system. We have made more than thirty specific recommendations towards this goal that are contained in the text and appendices of our report. These recommendations require MCPS to: (1) develop an explicit triage system for determining rapidity-of-response necessary for specific complaints, (2) enhance its technical ability for investigating complaints (increased number of technically trained and equipped MCPS staff plus budgets for outside specialists, when needed); (3) provide authority within its response unit to assure that problems are correctly diagnosed and that appropriate corrective actions are identified and implemented; and (4) respond to all complaints.

In summary, MCPS is faced with the challenge of fixing existing problems and preventing new ones from occurring. It must construct new and renovated buildings correctly, and do its best to keep older buildings functioning at optimum levels. MCPS must maintain the policy view that good indoor air quality is a prerequisite to learning and that prevention is less costly than after-the-fact mitigation. By emphasizing good IAQ in every classroom, MCPS can put into practice its mission to provide “Success For Every Student.”

1. Introduction

Indoor air quality (IAQ) problems have been occupying an increasing amount of parent, staff, and MCPS management attention in recent years. In August 1997 the Associate Superintendent for Supportive Services, David Fischer, convened an Indoor Air Quality Process Action Team (IAQ PAT) to provide him with insights as to the causes and solutions to such problems. This is the final report of the IAQ PAT. It presents our understanding of indoor air quality-related problems at MCPS facilities and makes recommendations for achieving and maintaining good indoor air quality at all MCPS schools.

Indoor air quality concerns have grown for a number of reasons. The incidence of child-onset asthma and allergy problems has been increasing throughout American society. Information about indoor air quality is routinely published in newspapers and broadcast on television. There have been rising community concerns (as well as those within MCPS) about the health and well being of staff and students and the ability of students to learn in air quality-compromised environments. Many people are also concerned about the declining effectiveness of MBPS's current procedures for addressing indoor air quality problems.

These concerns led the Associate Superintendent for Supportive Services to organize the Indoor Air Quality Process Action Team. The team consists of key MCPS employees within the Department of Facilities Management, an MCPS principal, representatives of the PTA and three employee unions, the County Government's air quality planner, the Montgomery County Health Officer, the Associate Superintendent's assistant, and a private sector indoor air quality specialist with a national reputation. The team was given a broad mandate to examine issues and make recommendations.

During the months of September-November, 1997 the team met weekly and used the continuous improvement procedures for process improvement and problem solving, as requested by the Associate Superintendent. We reviewed technical, managerial and other documents and reviewed case histories at a number of schools. Current procedures for maintaining buildings and investigating complaints were reviewed, including a pair of detailed flowcharts of the current

complaint process. Engineering, health, maintenance and IAQ-investigation information was studied. Communications procedures, goals, and related management issues were discussed. Opinions and evidence about the prevailing culture for raising and handling various problems (including, but not limited to, IAQ complaints) within the system were considered. During one week the entire team attended a statewide conference on school IAQ to listen to other air quality specialists in Maryland concerned with the same subject. The PAT had the opportunity to review: the management structures; our combined personal knowledge of MCPS IAQ practices; training; resources; and management attitudes towards prevention and/or resolution of indoor air quality problems. In summary, the team invested considerable effort in understanding the topic within the MCPS domain.

We find that indoor air quality problems in MCPS schools are the cumulative result of widespread deficiencies in the design, construction, maintenance, operation, and crowding in Montgomery County Public School facilities. As well, MCPS has applied inadequate resources to investigate, formulate, and implement corrective actions. The Indoor Air Quality Process Action Team finds, therefore, that improvements in MCPS indoor air quality can only be achieved by changes in the fundamental approach to this issue. Reorganization of only selected units will be an incomplete response, as will be elucidated within this report.

2. Background Technical Information

Indoor air quality (IAQ) is a broad subject that crosses many disciplines, including human health and health risk assessment, industrial hygiene, microbiology, building science, mechanical engineering, energy management, risk communication, and public school administration. For this reason, this report cannot provide a technical exposition of the subject. We do include the following discussion to assist the reader with the basic facts and terminology necessary to gain an introductory understanding of this subject. Supplemental general information is included in Appendix A.

The term "indoor air quality" broadly refers to the contamination levels of the air breathed within buildings. Insofar as most people spend upwards of ninety percent of their time indoors, indoor air quality can be a significant concern. Such concerns extend beyond MCPS because its students and employees also reside, worship, and recreate in other indoor environments. These concerns are usually more focused when affected individuals find they cannot easily avoid a specific space that seems associated with adverse health symptoms. Although this report addresses school building air quality, the PAT wishes to emphasize that school buildings are not the only indoor environment to which its people are exposed.

Outdoor air quality has been regulated at the federal, state, and county level for twenty-eight years. The subject is characterized by major federal legislation and a voluminous regulatory history at all governmental levels. In this area, levels of outdoor contaminants are all within federal health standards with one exception, ground-level ozone. Ozone is a summertime problem and therefore not one that is present during the normal school year.

In contrast, indoor air quality is largely an unregulated subject with few standards. In Montgomery County, as elsewhere, school IAQ problems include the persistent presence of microbial contaminants (e.g., molds and other fungi), volatile organic compounds from school construction materials, and concentration of human effluents (bioeffluents) from normal metabolic processes. One characterization of contaminant sources is shown in the Table 1, borrowed from Appendix A. The presence of sources does not necessarily lead to poor IAQ. Emissions may be

adequately diluted if sufficient amounts of clean outdoor air is brought into school buildings by properly designed and maintained ventilation equipment. Conversely, if ventilation equipment is under-designed, improperly utilized or maintained, or overloaded by classroom crowding, then poor indoor air quality will inevitably occur.

Table 1
Typical Sources of Indoor Air Pollutants

Outdoor Sources	Building Equipment	Component and Furnishings	Other Indoor Sources
Polluted Ambient Air • pollen, dust, fungal spores • vehicle emissions • local commercial sources *Nearby Sources* • loading docks • dumpsters • unsanitary debirs or building exhausts *Underground Sources* • pesticides • leaking tanks • radon • poor drainage	*HVAC Equipment* • microbial growth in drip pans, ducts, coils, and humiifiers • improper combustion product venting • duct contamination • duct disconnects • clogged filters • corroded unit ventilators *Other Equipment* • badly designed, leaking bldg envelopes • office machines • clogged vents • shops, labs, bldg cleaning	*Components* • offgassing of volatile organics from bldg materials • microbial growths on ceiling tiles and carpets *Furnishings* • emissions from new carpets and floors • dust-generating products, surfaces	*People* • bioeffluents • crowded classrooms *Other* • science labs • food pareparation • pesticides • consumer products • wastes • graphic arts materials • vocational training • restroom smoking

The effects of poor indoor quality fall into two broad categories. For healthy people, adverse effects often consist of bundles of real but vague symptoms including:

- unacceptable odors that make functioning difficult
- headaches, fatigue, dizziness, nausea
- respiratory distress; shortness of breath
- sinus congestion, cough, and sneezing
- eye, nose, throat, and skin irritation
- inability to focus on tasks
- adverse behavior changes

These facts should generate caution in MCPS management. For asthmatic and other respiratory-impaired individuals, poor IAQ can trigger asthmatic attacks that lead to lost class or teaching time, painful breathing, emergency room visits, hospitalizations, and even death. Chronic exposure of asthmatic children to a poor IAQ environment may have significant health

consequences. Microbial growth in areas of excessive humidity presents a variety of health hazards. Mold, the most common of all allergens, can aggravate allergic rhinitis, sinusitis, and asthma. Standing water in malfunctioning equipment may harbor Legionella bacteria and cause serious respiratory infections.

Most importantly, poor indoor air quality is a problem for everyone because it can lead to a reduced ability of students to learn and for teachers, administrators and support staff to be productive. As much as any specific concern, the IAQ Process Action Team believes that this issue-the degraded ability of students and school staffs to perform their basic function due to poor IAQ- should be a primary concern of MCPS senior management and the Board of Education.

The proper functioning and positive perceptions of our public school system are critical to the economic and social well being of the county. Our basic message is that senior management needs to address the issues discussed herein in a timely and adequate manner. Management and the Board have a vital responsibility to students, staff, and to the larger community. We rely on a good school system to attract and hold businesses and citizens that sustain the life of the county.

3. Goals and Principles

Achievement of good indoor air quality occurs only if a concerted, intelligent, integrated program of proper design, building utilization, maintenance, and problem resolution is in effect. Good IAQ does not happen fortuitously. Rather, good IAQ is the result of a committed management that supplies and supervises the use of adequate resources for proper school design and construction, school maintenance, and proper response to inevitable problems. That response system, in turn, is characterized by a system that encourages timely and accurate problem reporting, effective problem diagnosis and the formulation and implementation of the right corrective actions. Such corrective actions are ones that result in the satisfaction of the complainant and excellent communication of the results to all concerned.

We found that such a systems approach to the subject needs to be implemented within MCPS. To guide the formation of a proper systems approach, we concluded that a set of organizing principles had to be developed. These principles should serve as the design and operating foundation for any process, personnel, resource, or other change to effect good indoor air quality. In turn, the team found that there was no agreed definition of good indoor air quality and, therefore, also believed it important to create such a definition.

The Indoor Air Quality Process Action Team strongly recommends that MCPS management and Board of Education accept the good indoor air quality goal and principles written below. This goal emphasizes the importance of each school's ability to perform its functions. Children can learn well and staff can perform their professional duties well only if a school routinely has acceptable indoor air quality.

These principles describe a coherent approach to indoor air quality management. The first principle recognizes that children are growing individuals, with developing lungs and brains. They should not be subjected to levels of air pollution that are deemed suitable for adults working in industrial environments.

Goal

To achieve, maintain, and where necessary, to restore an indoor air quality environment in which everyone in a Montgomery County Public Schools (MCPS) facility can perform the necessary tasks of learning, teaching, administering, and sustaining facilities in a safe and healthy manner.

Principles

To achieve this goal, we conclude that MCPS should adopt the following principles.

1. Indoor Air Quality Standards and Children

Standards must be appropriate for adults and children. Children are not little adults. When there is doubt, school authorities should attempt to provide a margin of safety for children that may not be explicit in current adult-oriented industrial air standards.

2. Design/Construction/Space Use

New and modernized buildings should be designed and constructed to achieve the IAQ goal and comply with the latest building code requirements. Buildings should be designed to reflect realistic use forecasts and should be commissioned to demonstrate that the design requirements have been met. Renovated spaces or space used for a new function should meet the IAQ goal. Measures to achieve this goal may differ from those used in new buildings.

3. Materials in Schools

No material should be introduced into a MCPS facility, during the construction, build out, furnishing, occupation and use, and maintenance phases unless there is a positive knowledge that it will not create an adverse effect on school occupant(s) or visitor(s).

4. Maintenance

Indoor air quality primarily should be provided by proactive operating and maintenance practices, not primarily in reaction to a complaint. All mechanical systems intended to provide clean IAQ should be built, maintained, and operated to design standards.

5. IAQ Complaints

a) All complaints should be addressed and resolved expeditiously.

b) When actions are taken to restore proper IAQ, the complainant, interested individuals, and organizations within the school community, should be informed of such actions in a timely manner.

c) Problem closeout should be based on satisfaction of the original complainant.

The second principle seems self-evident, that our buildings should be built to applicable code. Current county building codes require that any exceptions to strict code ventilation rates be based upon the maximum number of persons that will occupy each classroom and for each classroom period. Designs, should, therefore, never be based on desired-but-not-achieved "policy" class sizes. (This practice may also violate county code, as explained in Section 4.3.) This second principle also recognizes a positive duty to accept buildings from contractors only when MCPS has determined that each component of the building's ventilation system actually meets design requirements.

The third principle is intended to prevent MCPS from experimenting inadvertently with children. Building designers and architects should not use materials whose offgassing characteristics are unknown to them. MCPS should only use those materials and processes that it has ascertained do not release toxic vapors. Proper ventilation should be used during all processes involving odorous or hazardous materials. Certainly, for products that have the potential to emit Class I or II air toxic chemicals as defined by Maryland environmental regulations (COMAR 26.11.15), it is due diligence on the part of the Montgomery County Board of Education to assure that such chemicals cannot accumulate in "...such quantities as to be irritating or injurious to health..." [Montgomery County Executive Regulation 3-97, incorporating 1996 International Building Code (Chapter 4, 401.9), International Code Council, Inc., 1996]. Considering the potential adverse consequences of sensitizing a previously unsensitized individual, via low concentration exposures to such substances, MCPS should adopt this avoidance principle (and adopt procedures to ensure practical implementation.)

The maintenance principle is vital. Implicit in this principal is that MCPS must create and maintain information systems on all ventilation equipment. For example, one cannot maintain a unit ventilator to design standards unless the design specifications and equipment performance is known. Such information must be readily available to pertinent workers within the school system. Another implication of the fourth principle is that all relevant personnel must be trained to understand how to maintain mechanical equipment.

The fifth principle requires that MCPS management commit to address complaints seriously. Expeditious results cannot be achieved without such a commitment. There is now insufficient technical staff, knowledge, and other resources available within the current IAQ investigating unit to address complaints expeditiously. This principle also recognizes that a complaint has not been resolved until the complainant's issues have been resolved, to the complainant's satisfaction. Therefore, the complainant must be sought out to determine the success of any corrective action.

4. Why Do We Have Indoor Air Problems in Our Schools

Within the past three years, complaints about indoor air quality that are serious enough to come to the attention of the MCPS Safety and Environmental Health Unit have arisen in approximately half of the schools in the county. Approximately 125 complaint investigations, involving approximately 250 site visits, were carried out in FY 97 by this Unit. At any one time there are ten to twelve schools on the unit's "high priority-needs attention now" list. In the most recent year there have been thousands of work orders placed to repair equipment and related facilities, in order to improve indoor air quality. Parent groups have demanded action from the MCPS facilities management department at schools in every area of the county.

What are the reasons for this upsurge in complaints about indoor air quality in our public schools? Here is our summary view of the reasons for this attention.

4.1 Failure to Understand Problem Significance

Good indoor air quality is essential for learning. As stated by Dr. Clifford Mitchell of Johns Hopkins University Medical School [Maryland School Indoor Air Quality Workshop, November 1997, Montgomery Campus of JHU] and by Dr. Doris J. Rapp [“Is This Your Child’s World”, Bantam Books, 1996, p.140], inferior air quality in our classrooms can lead to students who find it difficult to concentrate on school instructional programs. The presence of poor indoor air quality presents barriers to learning every day; students who are required to attend classes in underventilated, moldy rooms cannot learn as well as students who do not face these challenges. As well, sick teachers, or teachers distracted by environmental health issues, cannot teach our children as well as those not affected. Further, poor air quality may have significant health consequences both for students and for staff, resulting in days lost due to illness, dependence on medications, frequent physician visits, hospitalizations, and possibly premature death.

4.2 Incorrect Operating Paradigm

MCPS often operates on the presumption that it will cost too much money to fix its indoor air quality problems. This is a false idea. The costs of creating a healthy school are more than offset by life cycle savings in maintenance, operation, building life, and reduced workman's compensation and other liability costs. As well, delayed repairs often lead to more expensive ones. In other words:

GOOD INDOOR AIR QUALITY COSTS LESS

However, as we discuss in the section on maintenance of school buildings, MCPS has followed the common, but false, paradigm that it is acceptable to defer IAQ-related maintenance until a problem is manifest. This approach depends on using ill-feeling people to detect problems. This paradigm also is built into the fiscal practice of separating capital and operating budgets in a manner that permits the appearance of lower capital costs for renovation and new building projects by not specifically accounting in the capital budget for subsequent higher maintenance costs.

4.3 Inadequate Building Ventilation and Envelope Design

First, most of the current complement of MCPS school buildings were designed and constructed to ventilation and occupancy standards that are significantly lower than today's standards. This fact leads to a disconnect between even the best possible air quality that can be experienced in most classrooms and the expectations of parents and staff. The MCPS design approach to providing school buildings with clean air, is to design and construct to ventilation standards imbedded in building codes. For non-residential buildings, including schools, code requirements are set on the basis of a specified amount of outside ("clean" or "fresh") air per person and the number of persons that are anticipated to occupy a given space.

To illustrate, the current county building code requirement for classrooms is that each classroom shall receive at least 15 cubic feet of fresh air per person each minute (15 cfm). The code also states that ventilation systems shall be sized to accommodate at least thirty-one students and one teacher in a typical new elementary school room. A simple multiplication of these

numbers indicates that the current design standard for each elementary school classroom shall be at least 28,880 cubic feet per hour. However, this standard was only adopted in 1995. From the mid-1970s, the same classroom only had to be supplied with 5 cfm per person or approximately 8500 cubic feet per hour. Maximum contaminant concentrations are inversely proportional to the amount of ventilation air supplied to a room. This example shows that most of our classroom systems cannot achieve clean air levels now required of new and renovated buildings.

The reason that proper ventilation is vital is that when insufficient ventilation is present, IAQ complaints rise. The National Institute for Occupational Safety and Health (NIOSH) has documented that when CO_2 levels rise above about 1000 ppm, complaints about headaches, fatigue, stuffiness, upper respiratory tract irritations, etc. rise. ["Guidance for Indoor Air Quality Investigations," NIOSH, January 1987]. Indeed, the MCPS Safety and Environmental Health Unit (SEHU) uses this NIOSH study as a guide for discovering inadequately functioning classroom ventilation.

Yet, only when a classroom is supplied with about 15 cfm of fresh air per student can CO_2 levels be held to less than 1000 ppm. Only the fact that older schools may have leaky door and window frames is now permitting some classrooms to be have adequate amounts of outside air, despite old ventilation equipment. MCPS does not know, or have any program to find out, which of its older classrooms falls into this category.

Old ventilation systems are dual-purpose systems; they both provide conditioned air for comfort (heating and cooling) and provide ventilation air. Both outside ventilation air and inside recirculated air that contain biologically-derived moisture from people, plants, and other organisms. Excessive moisture, if not properly managed, can lead to high relative humidity (RH) and hence, mold growth in classrooms. Many MCPS classrooms have mold growths because original HVAC equipment, including the commonly used unit ventilator, are not well designed to regulate condensed moisture, and therefore, interior RH levels.

In addition to adequate ventilation, school building envelopes must be specially designed to control the entrance of bulk water, to permit the proper draining of interior condensates, and to

regulate interior RH to levels below those needed to sustain mold growth. Many of our older buildings were designed at a time when the importance of controlling building moisture levels was less appreciated. As a residue, some of our mold problems can be traced to poorly designed building envelope-ventilation systems. As we describe below, inadequate maintenance has exacerbated such problems.

There is one other design issue (one that the PAT only indirectly examined) that concerns designs for new buildings. With the advent of energy efficient building design, our new buildings have become considerably tighter. They are controlled by complex computer programs that regulate the flow of outside and recirculated air in "variable air volume" systems. Such VAV systems can be problematic for moisture control. As noted by an T.E. Cappellin, P.E. (ASHRAE Transactions, 1997, V.104, Pt. 2), "At their worst, (a VAV system)... fails to maintain space humidity within acceptable limits.... Poor humidity control can have another and previously unforeseen, consequence. It can promote the growth of mold, mildew, and other living organisms that lead to poor indoor air quality." It would be prudent for the Associate Superintendent for Supportive Services to assure himself that MCPS procedures prevent poor VAV designs from being approved.

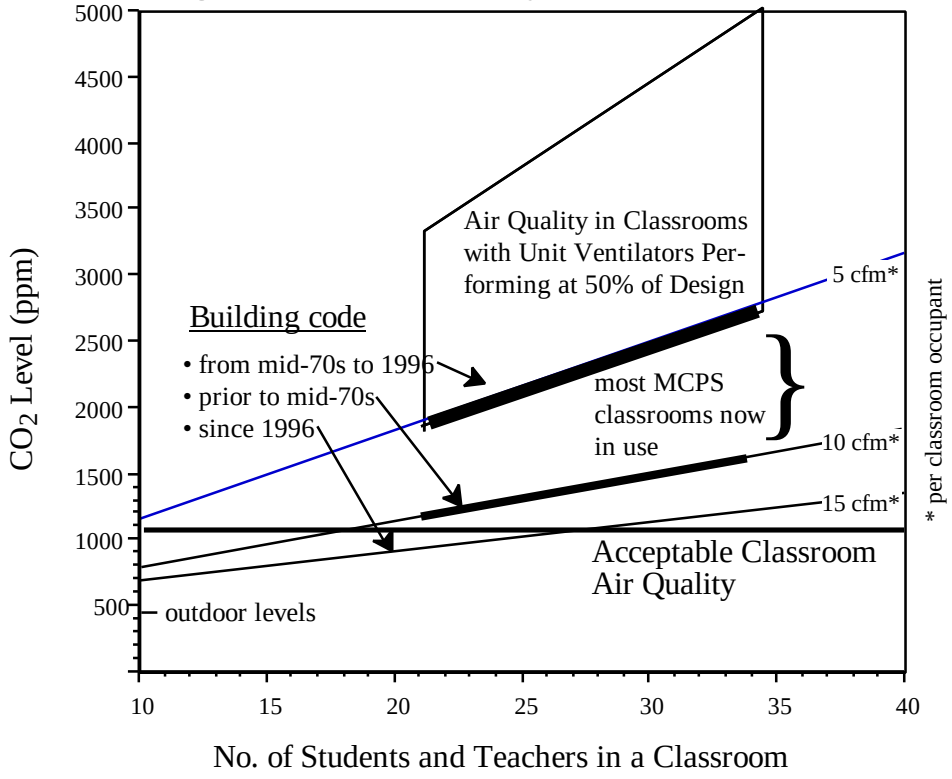
4.4 Classroom Overcrowding

Poor ventilation is exacerbated because the school-based operation and maintenance of ventilation equipment has been abysmal. (More about maintenance below.) Another factor is that many of our classrooms now contain a larger number of students than they were designed for. A consequence of increasing classroom populations is that air quality decreases, because the ventilation system in place in an existing classroom can only deliver its designed capacity. This relationship is shown in Figure 1.

In this figure, air quality and ventilation efficiency are measured by the concentration of carbon dioxide gas in the room. While this gas is not directly a toxic gas at these levels, it is widely used by ventilation specialists to measure the "staleness" of air in rooms. CO_2 is given off by people during respiration, and numerous studies indicate that air quality complaints rise when concentrations rise above 800-1000 ppm. As can be seen in the figure, most MCPS classrooms

will test considerably over this figure (except those with leaky doors and windows) because when they were built, building standards required less outside ventilation air than is required today. Thus, even if no other source of contamination is introduced into a classroom built to older designs, and even if all ventilation equipment is working properly, air quality will be considerably degraded from current standards and expectations. (If, due to poor maintenance, the actual amount of outside air delivered to a room is reduced further, then CO_2 levels can rise even higher than permitted by older designs. The 50% reduction-in-supply case is shown in Figure 1.)

Figure 1 Air Quality in MCPS Classrooms

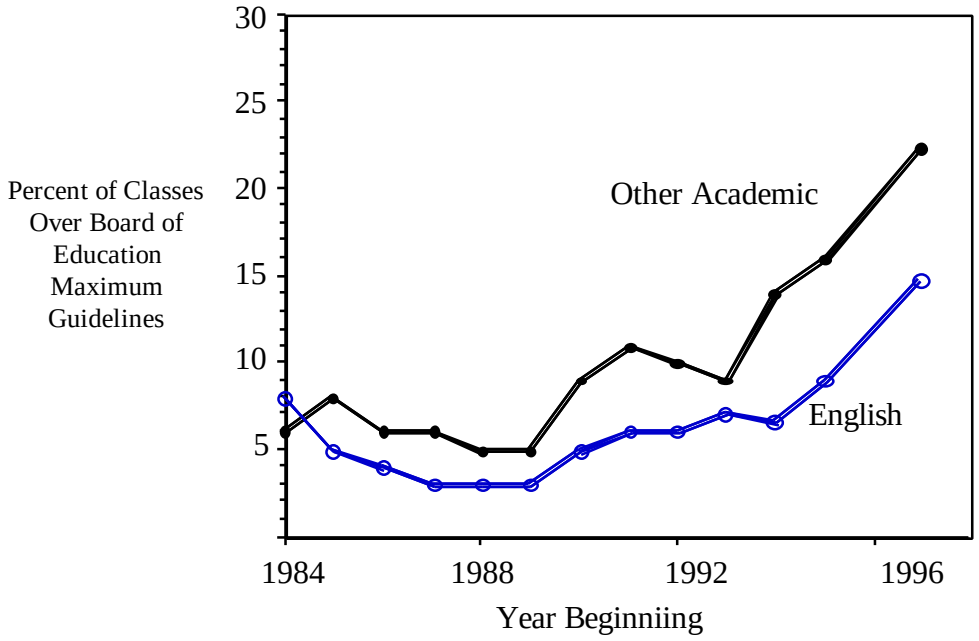


Classroom population growth contributes to this baseline problem. The "average" size of many classes considerably exceeds both the desired maximums “set” by the MCBOE and those used to design the original ventilation systems for MCPS buildings. Figure 2, applicable to MCPS high schools, illustrates this growth, already familiar to MCPS leadership. (Similar curves could be shown for middle and elementary schools.)

Although class sizes in our high schools, for instance, may currently average 25-27 students, data supplied to the IAQ PAT by an MCPS demographics specialist also indicates that some 40% of high school classes exceed 30 students. In such crowded environments, even well maintained ventilation equipment will become overloaded, as is indicated in Figure 1.

Figure 2

Increasing Class Size in MCPS High Schools



(from data provided to IAQ PAT in October 1997)

The entirety of Section 4 is about how we came to have our current problems. In this subsection we have described why existing building stock are IAQ-problematic. The remainder of this subsection focuses on how we can build and renovate ourselves to inherently cleaner buildings. MCPS operates under the jurisdictions of three building code organizations. These organizations update their building codes on a triennial cycle. These are the Department of Permitting Services for the county and the permitting organizations in the City of Rockville and the City of Gaithersburg. Each of these agencies requires MCPS to conform to the same building standards, those found in the 1996 International Mechanical Code, Chapter 4 (Ventilation). This code was adopted in the county in mid-1997. It substantially upgrades outdoor air requirements to classrooms over requirements in the building standards embodied in the prior code. The next paragraph describes a team concern over the manner in which these codes are being implemented.

As stated above, current code requires 15 cfm of outside air per person in each classroom. There are no exceptions to this requirement. The minimum number of people to be assumed to occupy classrooms is also specified by current code as 50 per 1000 ft^2 of room area. Insofar as typical MCPS classrooms (i.e., not science labs or auditoriums) are standardized at 900 ft^2, codes require the Division of Construction to design to 45 people per classroom (i.e., 1 teacher and 44 students). Because our classrooms are never this crowded, the Division of Construction must either overdesign HVAC systems for new or renovated buildings **or** invoke a specific clause in the building code that envisions such a problem. That provision (found in 403.3 of Chapter 4) is as follows:

> **EXCEPTION:** The occupant load is not required to be determined based on the estimated maximum occupant load rate indicated in Table 403.3 (i.e., 50 per 1000 ft^2) *where approved statistical data document the accuracy of an alternative anticipated occupant density*. (italics added for emphasis)

By code, approval is obtained from the code agencies, not self-granted from the building permit applicant. Thus, the lawful means by which MCPS can design classroom ventilation systems to less than 675 cfm per room (i.e., 15 cfm per person x 45 persons per room) is for MCPS to actually perform the statistical study described in the exception provision. That is, MCPS is obligated to determine for each new school, and each classroom therein, the actual upper limit on future classroom occupancy, based on the demographic, budgetary, and other technical factors. MCPS may not base its new building applications on Montgomery County Board of Education policy about ideal classroom sizes as it did under the code cycle that ended on June 30, 1997.

Our best information is that the upper limit for high school designs will be in the vicinity of 35, not 45, people per classroom. Yet, studies to verify this estimate are only now being contemplated. Current MCPS building design guidance uses 26 people per room.

4.5 Poor Maintenance of Mechanical Equipment

Another major factor that contributes to today's poor IAQ in MCPS buildings is that for a period of at least ten years, ventilation equipment has suffered from inadequate preventive

maintenance. The Division of School Plant Operations supervises school-based building staff who are responsible for routine basic equipment maintenance. An example is the routine replacement of unit ventilator particulate filters. The Division of Maintenance is responsible for more in-depth equipment maintenance, such as the rebuilding or replacing of malfunctioning unit ventilators.

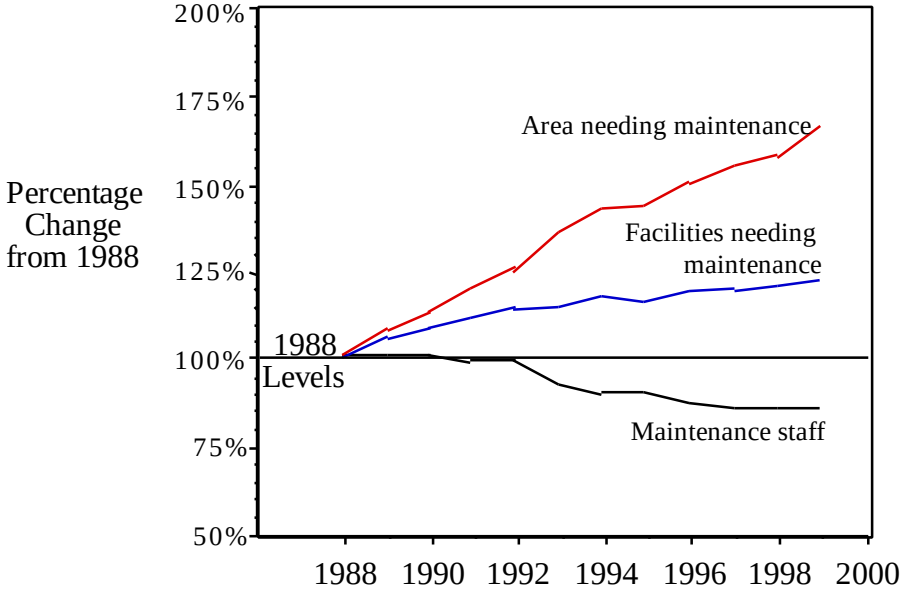
Since 1988, the Division of Maintenance has not spent any money for the preventive maintenance (PM) of elementary or middle school unit ventilators, high school air handling units, and other mechanical equipment essential to provide clean air to our classrooms. Between 1982 and 1988, the Division of Maintenance had begun a program of such PM. This program consisted of dedicating three teams of trades people to this specific function. During this period, approximately 30% of the maintenance budget was spent on this program. He recalls that the PM program was successful in that once it had functioned for several years, IAQ complaints were noticeably reduced.

In 1988 budget cuts forced the termination of this program. Since then, the Division of Maintenance asserts that their inability to perform basic PM of such equipment has increased, due to increased demands on a continually reduced staff. Facts to support this argument are shown in Figure 3. (This figure was plotted from data supplied to the PAT by the Division of Maintenance.)

The apparent decline in maintenance division resources is only part of the story, however. The IAQ PAT has concluded that these resources have not always been used wisely. No systematic database exists that catalogues the models, designs, performance characteristics, part sources, and other relevant facts about ventilation, piping, and other equipment and facilities pertinent to maintenance of good IAQ. The training of maintenance personnel has not been adequate. There is no organized knowledge of how each class of equipment is supposed to operate or function. We have discovered that until very recently (and then only in some places), basic routine maintenance, such as filter replacement in unit ventilators, has not been performed.

Figure 3

Decline in Maintenance Resources



One result of this history is that there is an inventory of malfunctioning “important clean air equipment”, such as unit ventilators and air handling units, now installed in our buildings that fail to perform to original design specifications. Figure 1, entitled "Air Quality in MCPS Classrooms", shows how this can affect real classroom air quality. The top line in this figure represents a unit ventilator that is delivering only half the design air flow for a building built before 1995. Numerous elementary and secondary schools tested have elevated CO_2 levels. One school classroom recently measured 4500 ppm. Consequently, these rooms' ventilators are delivering substantially less than code, even under old code, requirements.

Decreased outside airflow is only part of the maintenance issue. Dirty unit ventilator internal surfaces are often fouled with mold populations. Apparently some units have never been cleaned; others have not been cleaned or maintained in years. There are no documented records of when such equipment has been inspected, cleaned, and repaired. In a recent clean up of such devices at one elementary school, unit ventilators were found encrusted with fungal matter directly in the conditioned air stream being blown into classrooms filled with students. In another elementary school, fungal colonies were found growing on carpets and other surfaces at concentrations that were orders of magnitude in excess of densities in clean areas. In another school, disconnected ducts, broken fans, and dysfunctional exhaust systems were found to be common.

We single out one further example of dysfunctionality because we believe it is easy to remedy and therefore a measure of the level of past maintenance work in the past. Most schools equipped with classroom unit ventilators are also equipped with hallway exhaust systems. The design idea is that for every clean cubic foot of air introduced to a building from the outside, another cubic foot of stale air has to be exhausted back to the outside. Such a system is said to be in balance. Balance cannot be maintained if exhaust fans are turned off, if internal components are not clean, or if parts are broken. Yet, in a number of high visibility IAQ cases within MCPS, lack of air balance has been observed. The implication of such observations is that insufficient attention had been paid at those schools to air balancing as a matter of normal maintenance.

In order to permit MCPS management and the Board to solidify their understanding of these facts, we provide two case studies as Appendices B and C. Synopses of these case studies follow. These synopses also illustrate management attitudes towards IAQ complaints and the absence of concerted commitment to either rectify the circumstances, to provide timely resources, or to be forthright with community groups. These issues will be discussed in some detail later.

Kensington - Parkwood Elementary School (KPES) Synopsis

In the week prior to the opening day for the 1997-1998 school year, a teacher and the building service manager at KPES found mold in two classrooms. According to staff, the mold, black and green in appearance, covered large parts of the walls, shelves, furniture, counters and toys, and emanated an extremely strong odor. Although the teacher experienced severe respiratory distress when in the rooms, school opened without the problem having either been identified or even seriously acknowledged by the school. Following school opening, three other teachers and some children also experienced adverse health reactions while in the rooms, and the investigation was expanded to include four rooms.

Although the presence of mold in the four affected classrooms was visibly obvious and should have warranted immediate action, SEHU did not act in a timely manner nor did they address the problem with credible solutions. By the sixth week after the onset of the problem, SEHU had still not notified the Division of Maintenance. Only after community pressure and personal notification of the director of the Division of Maintenance were the classroom unit ventilators disassembled and properly cleaned, and the moldy carpet in the four rooms replaced with tile. In response to public outcry, all the unit ventilators in school were also cleaned. The condensate drainage pipes were found to be clogged in approximately three of every four units in the school, and each of the condensate pans were lined with a layer of organic matter. Components of these systems were seen to be corroded, waterlogged, or otherwise dysfunctional. During disassembly, the responsible personnel did not understand the intended function of many of the unit ventilator components.

After cleaning, an SEHU contractor conducted microbial testing in the four originally investigated classrooms. These tests showed the continuing presence of unacceptable contamination of two of the unit ventilators, albeit at lower levels than must have existed prior to cleaning. MCPS responded to these findings by re-cleaning the unit ventilators in these four rooms. However, there are currently no plans for confirming that these actions have achieved the desired purpose or for addressing the unit ventilators in the rest of the school.

In December 1997 and January 1998, two additional teachers located in other parts of the school filed indoor air quality complaints to SEHU, apparently due to severe allergic reaction to mold. However, as of early February, no one from MCPS had investigated these problems.

The seriousness of the problem was downplayed repeatedly, and it was apparent that the methods used by MCPS for resolving these problems addressed only the symptoms and were unlikely to discover and rectify the root causes. The lack of forthcoming communication and minimization of the seriousness perpetuated frustration within the school community.

Belmont Elementary School Synopsis

As Belmont reached its 20th year of existence, various components needed to be replaced. In 1992, new carpet was installed. In 1993 the roof was replaced. In the summer of 1994 a new gymnasium floor was installed at this school. This floor was a composite polymer material, poured in liquid form and allowed to "cure" in place. While this process has been used at other MCPS buildings, on this occasion problems with the application were not noticed by school personnel. During the autumn staff, parents and community members noticed odors in the new gym and inquired as to the nature of these odors and whether the gym was safe to use.

There ensued several rounds of requests for comprehensive appropriate tests to identify and quantify the specific volatile organic compounds present in the gym's air. MCPS did not perform any such tests. SEHU persuaded Maryland Occupational Safety and Health Administration (MOSH) to perform tests for a few species five months after school opened. However, SEHU did not recognize that the MOSH protocols were being performed against industrial standards and could not be compared to safety levels appropriate for children. Community pressure for testing continued and by the end of the 1994-95 academic year MCPS finally contracted for proper testing -for a few of the suspected contaminants.

Meanwhile, and only because of community complaints, the SEHU, in conjunction with the Div. of Construction, tested the functionality of the gym's ventilation system. These tests showed that the gym's ventilation fans were delivering only 20% of their design flow. Furthermore, and perhaps as important, a study of the ventilation system for the main school building showed that the entire building was out-of-balance, had dysfunctional fans, and was not working in proper concert with the gym's ventilation system, that was internally dysfunctional.

Numerous meetings with school system personnel from the Facilities Management Department have occurred. In 1995 MCPS agreed to hire an independent contractor study the building's ventilation system. A 1996 follow up inspection showed 1995 recommendations had still not been implemented. In 1997 new Associate Superintendent approved of new testing that indicated that there were problems associated with airborne aerosols, fungi, dust mites and other allergens. Remedial cleaning was attempted in July and August 1997. Follow up air quality testing demonstrated continuing problems and in late August 1997 the decision was made to remove all of the carpeting in the building.

The preceding synopses illustrate a key point about the Division of Maintenance and the maintenance elements of the Divisions of School Plant Operations. Although planning is the first step towards effective management, there were no school-specific building maintenance plans to which the investigators could refer. Each situation seemed to rise, as if prior incidents had not occurred. This absence is noteworthy because particularly in circumstances in which many unknown variables exist, proactive strategic planning is essential.

Rather, MCPS has been responding to school IAQ problems reactively, in a "band aid" approach (this, in an environment in which the size of reactive band-aid resources is shrinking.) For instance as of September 23, 1997 there was a backlog of nearly 7,000 work orders in the system. The Division of Maintenance reviews all work orders that have not been completed in 60 days. Schools are contacted to determine if the work is still needed. Usually (though not necessarily) these are requests of a non-critical nature. Depending on the response received from the schools, some of these work orders are dropped from the queue if they are considered to be non-critical or redundant. We were not able to discover an operating definition of “critical.” If work orders were tagged with a “health-critical” flag or label, then the more important work orders could be processed in a sequence that reflects their priority (see parallel comments on triaging of IAQ complaints in Section 4.7).

Consequently, of course, customers become dissatisfied and environmental health issues also become backlogged. Management response to this backlogging (triaging of complaints, public minimizing of their importance, and pressure to assert that "solutions" have been found), is the subject of subsequent sections.

4.6 Energy Management Issues

The IAQ PAT has concluded that certain energy management functions are unintentionally depriving students and teachers of adequate indoor air quality. Partly this results from a communications failure between SEHU and Energy Management. The latter organization, lodged within the Division of School Plant Operations (SPO), does not have the routine means to determine the build up of air contaminants in a specific building. Thus, for instance, if ventilation tests conducted by, or under the auspices of, the Safety and Environmental Health Unit, indicate

that a build up of air contaminants in schools during the school day do not return to background levels even by the next morning, it may be necessary to use ventilation equipment during evening hours to achieve acceptable air quality. (Otherwise, a Monday-to-Friday build up of people-produced contaminants will occur. In such schools, air quality on Friday is worse than on Wednesday afternoons, which in turn is poorer then than on Monday mornings.)

Which classrooms, or entire buildings, fall into this category depends on tests and analysis performed by the SEHU. This organization does not routinely measure ventilation performance. (Note: in current MCPS practice, ventilation efficiency is only rarely measured by anyone. This means that this function is also not routinely performed by SPO's school-based custodial workers.) When SEHU does obtain information that suggests a classroom is underventilated, it has not been their routine practice to communicate such findings to the energy management workers in the SPO Division.

4.7 Inadequate Investigation Unit Capabilities

The Safety and Environmental Health Unit (SEHU) is one of the two organizations within MCPS routinely called on to investigate IAQ problems. The first line of investigation falls to the Building Service Managers in each school and their staffs and supervisors. BSMs are provided basic training in the physical hardware used to provide fresh air to school rooms. They have primary day-to-day responsibility for school building operation and basic maintenance. However, the SEHU is the investigative unit for the entire school system. The IAQ PAT has examined in some detail this unit's capabilities, performance, and needs. An overall assessment is that this unit is woefully understaffed, unempowered, and undertrained to carry out the functions to which it has been assigned.

The scope of the SEHU includes (a) investigating IAQ problems and managing the IAQ program, and b) providing services concerning traffic safety, fire code, accidents, hazardous materials treatment and emergency response, personal protective equipment, lead-in-water and paint problems, blood-borne pathogen program, and all other occupational safety and health issues. The unit has one supervisor and two professional field employees to perform these services for the entire school system.

Although there are more than 208 public school buildings, serving 125,000 students, and employing more than 17,000 staff, there is only one individual employed full time by the school system routinely to investigate IAQ problems. SEHU is placed in the impossible position every day of investigating problems with insufficient resources. Although the investigation of building IAQ problems often takes private practitioners several days, this unit can only spend a few hours on each problem, a condition that would leave private sector practitioners open to undue liability risk. The unit does not have a budget for testing air quality or to hire outside specialists.

Furthermore, the SEHU is not just asked to investigate the causes of IAQ problems. It is also tasked to work with other MCPS organizations to identify the solutions to such problems. The Unit has no authority to actually direct solutions. Recommended solutions can be contested by other units. (see next section on corrective action board). Current procedures require the SEHU supervisor to try to resolve complaints by securing the attention and agreement of the facilities department manager who may not be receptive to IAQ complaints because the solutions to these problems may compete for budget and may raise unwanted precedents at other schools.

The SEHU operates by triaging complaints that are sent to it through the system. The Unit is genuinely concerned with problems that range from the simple to the complex to the immediately dangerous. Yet, it does not have a formal procedure for deciding whether a problem is worth its immediate attention. Because it is understaffed, school communities are told to "wait their turn."

While schools "wait their turn", school administration, teachers, other MCPS staff, students, parents, and community groups become disenchanted with response time, response quality, and candor. Necessary school-community trust is eroded. Frustrated individuals learn to rely on the media to convey their needs to higher management. As school buildings age, MCPS will likely experience more of this pressure if inadequate resources are not provided. However, because of the integrated nature of IAQ problems, the school system will also have to learn to integrate its skilled people more effectively.

As indicated in other sections, re-investment in the SEHU is only one of many necessary steps to rectify MCPS IAQ process, resource, and commitment-to-improvement problems.

4.8 Absence of Corrective Action Board Process

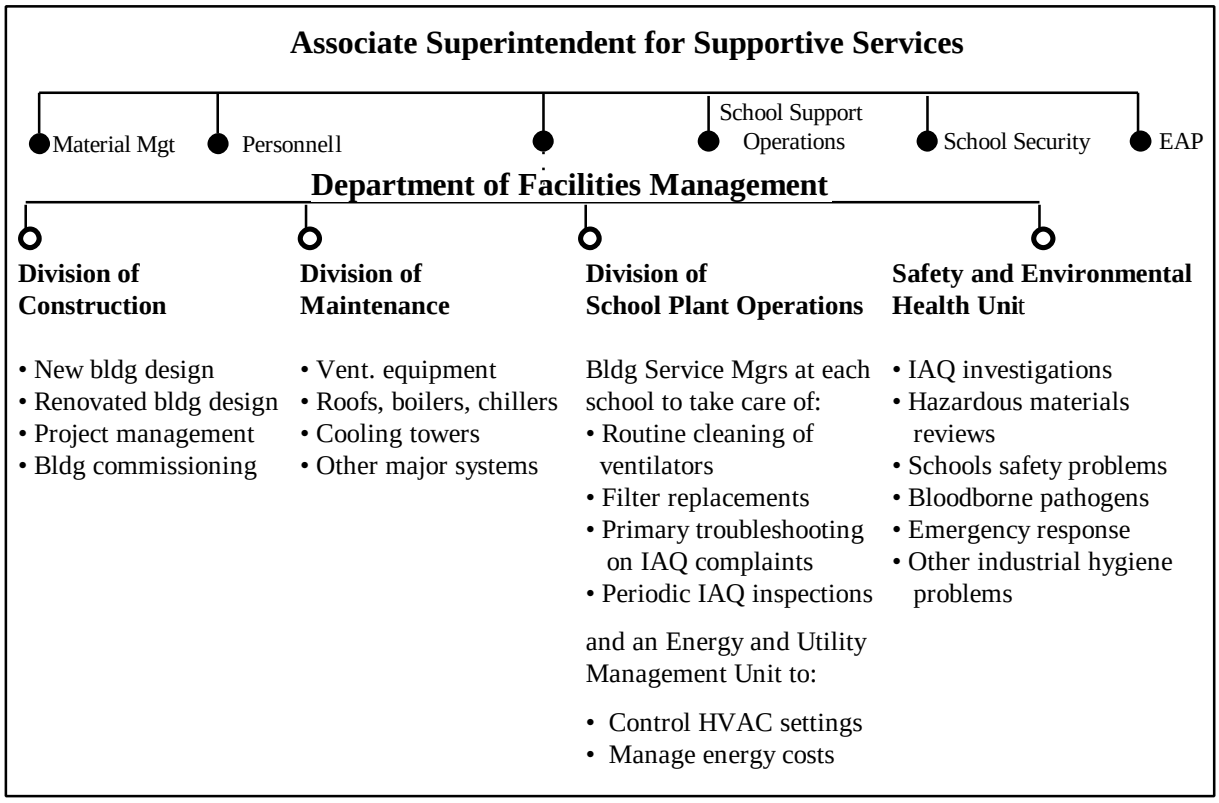
There is no corrective action board or team within MCPS that is brought together on an as-needed basis to decide on the best course of action to mitigate an indoor air problem, once one is investigated. As a result, the optimum mitigation may not be identified because the relevant personnel are not brought together. In today's indoor air quality practice, successful problem solving emphasizes integrating the skills of different specialists. At MCPS, although specialists in different groups may informally converse, there is no formal procedure, captured in a "corrective action document", signed off by relevant disciplines, that reflects mitigation team decisions.

To illustrate, mold problems often result in SEHU's recommending cleaning obviously contaminated surfaces with bleach/water solutions. This is called "sanitizing." Sometimes, this approach may only generate additional mold growth in now-moistened surfaces, whereas invisible-but-present mold goes undetected. Sometimes the source of moisture or food upon which the mold is dependent is uninvestigated and therefore not corrected. This, of course, can lead to the need for a subsequent recleaning. If building envelope or pressure management issues are sources of undesired moisture, then a building engineer may be needed. The major point is that the problem investigator may not have the necessary information, training, or background to make the final mitigation decision. A judgment as to whether the "root cause" of the moisture should be sought is probably best obtained by the convening of a mitigation or corrective action board.

4.9 Lack of Management Commitment and Vision

The current management of indoor air quality programs resides with organizations shown in Figure 4. This figure also shows their specific responsibilities and reporting relationships. Collectively the four technical units that are responsible for design, maintenance, operation, and investigation report to a Facilities Manager who in turn reports to the Associate Superintendent for Supportive Services. This Associate Superintendent also has responsibility for managing the Departments of Material Management, Personnel, School Support Operations, the Division of School Security and the Employee Assistance Program.

Figure 4
Current IAQ-Relevant Organization within MCPS



As is evident from Figure 4, many necessary disciplines are needed to achieve the integrated program of proper design, building utilization, maintenance, and problem resolution called for at the beginning of Section 3. Our view is that these divisions do not communicate well with each other. There is no coherence brought to integrate these divisions when they confront an IAQ problem. Further, the Division of Maintenance and the SEHU do not have adequate resources to monitor, identify, and remedy IAQ-related problems. This situation was exacerbated by the 1988 choice to eliminate preventive maintenance (see Section 4.5) when maintenance budgets were reduced and by the rising number of MCPS IAQ problems.

There has been a deficiency in the commitment of resources applied to prevent and mitigate these problems. Emphasis has been placed on piecemeal approach to problem solving. When problems enter the system, typically after complaints at schools, elements of the relevant IAQ groups (see Figure 4) are assembled to provide the Facilities Manager with a quick "solution." An integrated proactive approach to achieving the IAQ Goal was not in existence at the time of this report.

Beginning in 1997, MCPS has begun to be more proactive at the school maintenance level. Additional SPO supervisors have been hired and building service manager IAQ training has been increased. There is still a need to identify priorities for building service staff that emphasizes the importance of proper maintenance of ventilation equipment. Part of this response may have been due to the convening of the IAQ PAT. Understandably, there is still a great emphasis placed on after-the-fact investigation and remediation. MCPS has been slow to integrate the many disciplines required to prevent problems.

Our team wishes to emphasize this point. Even though it would be an important improvement:

THE PRIMARY PLAN FOR ACHIEVING THE IAQ GOAL SHOULD NOT BE TO IMPROVE THE COMPLAINT RESPONSE FUNCTION

Rather, the key individuals responsible for designing, constructing, operating and maintaining systems should develop, and put into practice, proactive programs that anticipate and prevent problems from developing.

Management may not realize that within the MCPS culture, there is a perceived fear of reprisal for speaking openly about IAQ problems. Some MCPS workers stated to our team that for them to speak openly could bring management retribution. Management at different levels communicate their skepticism about complaint validity in a number of ways. For one, the word "complaint" is euphemized to "concern" or "issue" on the very complaint form (Form 230-23) staff are provided. Sometimes managers who are not professionally trained in the subject challenge the validity of complaints. Some MCPS workers believe that an operative culture inhibits acknowledgment of parent and staff complaints. Some teachers, particularly new teachers, have indicated that they perceive it may be risky for them to express an IAQ concern for fear that such an expression may affect their career advancement.

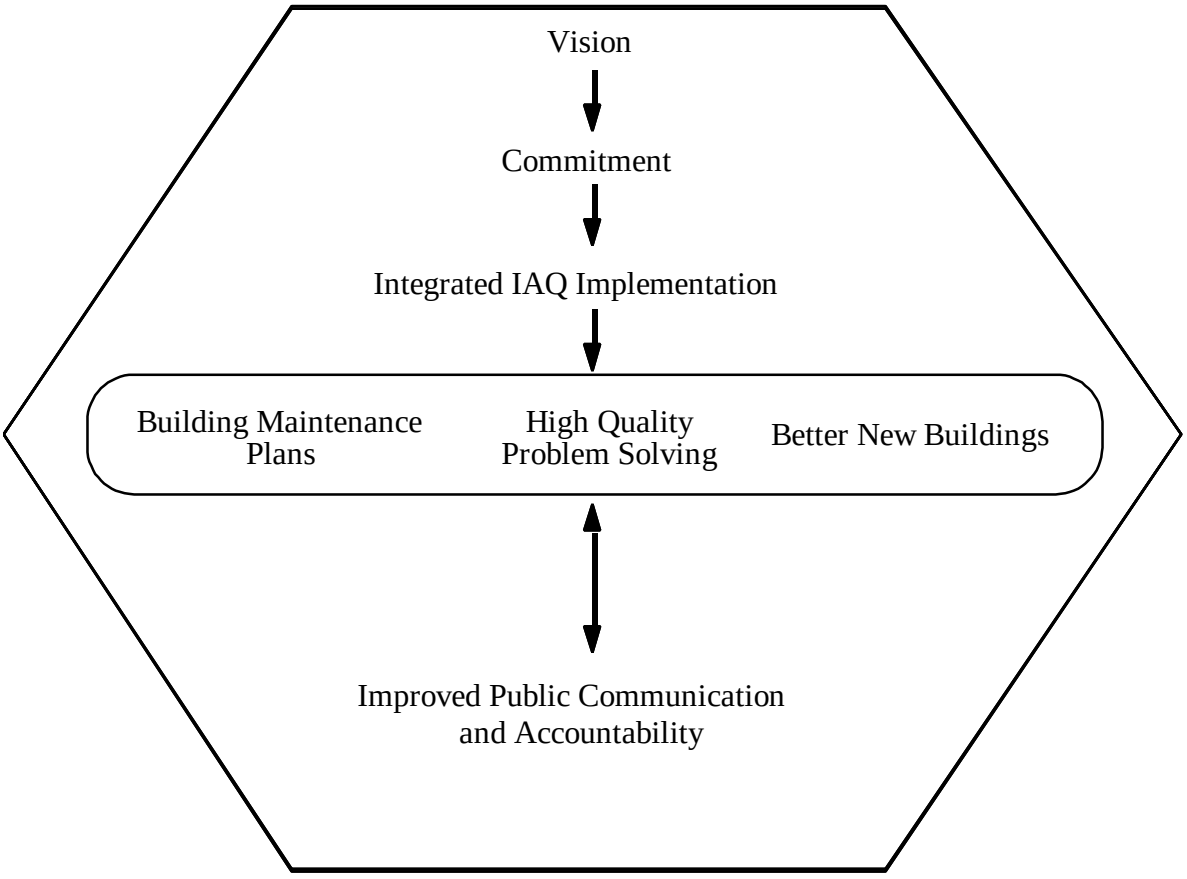
The team listened to one of its members describe the general MCPS culture that problems are to be solved at the lowest possible levels and that complaints about insufficient resources, technical assistance and the like, are not appreciated. Montgomery County Public Schools' culture accentuates the positive while downplaying negatives. Typically, school administrators are encouraged not to communicate information to their community unless they can say that

everything is fine. Reports are routinely considered confidential and often information is communicated over the telephone to avoid creating a paper trail.

5. RECOMMENDATIONS: How We Can Achieve Good Indoor Air Quality

The discussions in Section 4 point to a multiplicity of reasons for our current condition. Improvements will take time but they will occur if determined leadership is provided. The following technical and managerial recommendations are presented to improve indoor air quality in the MCPS, not just to improve MCPS response to new IAQ complaints. The core of these recommendations is shown in Figure 5.

Figure 5 Recommendations Overview



5.1 Vision: ADOPT the Indoor Air Quality Goal and Principles described in Section 3 of this report.

The specific arguments for adopting the recommended IAQ Goal and Principles are presented in Section 3. The IAQ Goal is an essential component of implementing the MCPS mission of "Success for Every Student." The IAQ Principles describe the basic conceptual framework needed to meet the fundamental IAQ Goal.

5.2 Provide managerial commitment to achieving and maintaining good indoor air quality.

5.2.1 Define budgets that provide adequate resources to the Divisions of Maintenance, School Plant Operations, and Construction and to the organizational unit that will incorporate the indoor air quality technical and oversight functions.

5.2.2 Argue for these in public to let MCPS people know senior managers are behind them.

5.2.3 Write a policy directive, reminder, or some other formal document to all managers and supervisors that directs complete candor in relationships with school principals, parent groups, and the community.

5.2.4 Be guided by good science and engineering. Do not compromise the facts.

5.2.5 Require competent technical performance.

a. Establish performance standards that require continuous technical improvement of relevant staff.

b. Fund staff training.

c. Examine the job descriptions and personnel folders of all IAQ-responsible supervisors and managers to ensure they have the necessary professional qualifications. Both on-the-job experience and technical knowledge are necessary for some of the IAQ-related jobs.

5.2.6 Level with the community that some schools, by reason of their design or age, challenge the ability of MCPS to provide good IAQ. Correspondingly, examine how operating and maintenance practices can be stepped up in such schools to offset design weaknesses.

5.2.7 Create a standing technical advisory committee on indoor air quality to the Associate Superintendent to provide an early warning on new issues and a mechanism for reviewing all IAQ-related.

5.2.8 Implement an IAQ Improvement Plan.

a. After considering these recommendations, MCPS should develop a written plan by July 31, 1998 that sets out how it will implement IAQ improvements.

b. Between August 1 and December 1, 1998 MCPS should implement a process for public feedback about this plan.

c. MCPS should explain the progress MCPS has made towards its implementation.

d. Retain an outside IAQ Auditor to perform an independent audit every two years of implementation of the IAQ Improvement Plan. Such an environmental audit would be wholly analogous to the annual financial audit performed by MCPS's financial auditor. See **Appendix E** for details.

5.3 Ensure Good Plant Design and Construction

5.3.1 Comply with latest building code requirements. To do this:

a. Communicate this necessity to the Division of Construction.

b. Establish a technical review process within MCPS to insure that all design guidance, plant designs, and new buildings will meet code.

c. If code exceptions are sought, document this intent and explain the reasons to the affected community prior to applying for a building permit.

d. Provide for 100% commissioning of new and renovated buildings.

5.3.2 Before proceeding with additional VAV HVAC designs, MCPS should ask the Divisions of Construction and Maintenance to provide the Environmental Oversight Officer (see Appendix E) with a technical justification for the continued practice of specifying such technology for new schools.

5.3.3 Establish a practice of having a formal review of any construction or renovation practice that introduces volatile organic compounds into an MCPS building that are defined as Maryland Class I or II air toxic substances.

5.4 Improve Facility Maintenance Substantially

5.4.1 Create Building Maintenance Plans (BMPs) for each school. These plans would be the equivalent of user maintenance manuals for automobiles. (MCPS has managed asbestos in this manner since 1988.)

The BMPs would contain all the necessary routine maintenance schedules. The plans would be living documents, tailored to the facts at each school. MCPS should:

a. Maintain a log of all equipment malfunctions, the logs of all work orders, and logs of all repairs as part of the BMPs.

b. Lodge the BMPs in each school, at each maintenance depot, and with the SPO area supervisor for the school.

c. Make the BMP the centerpiece of proactive school building maintenance. Insofar as maintenance is now a split function between the Division of Maintenance and the Division of School Plant Operations, have managers from both organizations sign each BMP.

5.4.2 Hold an annual (or more frequent) review at each school of the progress made towards implementing its BMP. Let the community know that such reviews are being held and post the results at the school.

5.4.3 Take an inventory of all ventilation equipment (This has never been done).

a. Establish a database of components, their current replaceability, and their original design capabilities.

b. Make this database readable by all maintenance, investigation, and managerial personnel who may be concerned with IAQ management.

5.4.4 Consider Recommendation 5.2.3 when you are hiring or promoting people into lines of responsibility for IAQ.

5.4.5 Establish a formal training program for plant operation and maintenance workers so they can be held to performance standards. Do not expect untrained workers to implement BMPs.

5.4.6 Reestablish the Division of Maintenance teams dedicated to inspecting and repairing unit ventilators and other ventilation equipment.

To be able to address the need for overnight repairs without incurring overtime costs, consider having a component of this team work an off-hours shift.

5.4.7 Develop a method of tagging work orders that are IAQ/health critical so that maintenance workers can attend to them on a priority basis.

5.4.8 Define and prioritize work loads and tasks of school plant operation workers

5.4.9 Provide appropriate staffing levels to the Divisions of Maintenance and School Plant Operations.

*5.5 Improve Problem Solving I*nvestigation and Remediation

5.5.1 Recognize that the primary method for achieving the IAQ Goal cannot be based on improving the complaint response function (even though that is important.) These recommendations that follow are not the most important ones we make in this report.

5.5.2 Reorganize the current SEHU into a larger unit separate from the Facilities Management Department with a Director that reports to the Superintendent, or at least the Associate Superintendent for Supportive Services, of MCPS. Give this unit four functions, as follows:

a. Responsibility for conducting high quality technical investigations of the most serious IAQ problems. This function also includes working day-to-day in an integrated (matrixed) fashion with each maintenance depot on developing and following up on IAQ mitigations.

b. Training the building service and Division of Maintenance workers who are both the first problem responders and who implement the BMPs.

c. Lead responsibility and authority for IAQ mitigation decisions.

d. Responsibility for communicating with the public about IAQ problems.

See Appendices D (p. D-4) and E for complete details.

5.5.3 Change the methods and philosophy by which field investigations are now made.

5.5.3.1 Develop written guidelines for field personnel to determine whether an environmental problem at a school is an emergency, is urgent (though not an emergency), or a problem that can be addressed in a non-urgent manner.

5.5.3.2 Assure that problems at all levels will receive some response.

5.5.3.3 Empower field investigators to act on these guidelines.

5.5.3.4 Revise Form 230-23 and 230-24 processes according to **Appendix D**. In particular:

a. Call complaints "complaints" by changing the title of the form

b. Do not close out complaint investigations unless the individual filing the complaint has been communicated with to determine whether the problem has been truly mitigated

c. Permit parents to fill out the complaint form as a matter of MCPS policy

5.5.3.5 Fund the investigation function so that there can be at least one full time field investigator for the schools at each maintenance depot.

Integrate this individual into the depot and overlapping SPO areas so that a sense of common ownership is developed (see also 5.5.2 and **Appendix E**)

5.5.4 Institute a Corrective Action Board process in each depot to be chaired by the new oversight unit technical representative attached to that depot with membership from the Division of Maintenance and other Facility Department representatives, as needed.

The arguments in support of this idea are presented in Section 4.8 and **Appendix E**.

5.6 Improve Communication

While we believe that proper communications between MCPS parents, staff, and the community is really integral with proper problem solving, we have chosen to present this in a separate section.

5.6.1 Change the perception that the primary function of MCPS community communications about IAQ is to justify prior practice or to defend budgets.

The primary communications philosophy should be to find out what true complaints are and to enlist community support to remedy them. In situations in which illness from home (not exacerbated at school) is the true problem, MCPS should consider forthrightly saying it believes this is the case.

5.6.2 Provide educational outreach materials to the community so that it can appreciate some of the IAQ issues. Make the U.S. EPA IAQ Clearinghouse telephone number (1-800-438-4318) widely available to requesters.

5.6.3 Look for success stories and tell them.

If there is a problem that MCPS becomes aware of prior to that information becoming known in the community, should consider communicating these first to organizations and interested individuals within the school community This will improve MCPS credibility.

Appendix A

United States Environmental Protection Agency | Indoor Environments Division (6607J) Office of Radiation and Indoor Air | EPA-402-F-96-004 October 1996

EPA

Indoor Air Quality Basics for Schools

This fact sheet provides important information on indoor air quality (IAQ) in schools to parents and others who do not normally occupy school buildings. Once you understand the basics that influence indoor air quality in a school, you will note that prevention and problem solving mainly involve two major actions — the management of pollutant sources, and the use of ventilation to control pollutants. Following are the key principles:

- Many IAQ problems can be prevented by school staff and students
- When IAQ problems happen, they can often be resolved using the skills of school staff
- The expense and effort required to prevent most IAQ problems is much less than the expense and effort required to solve problems after they develop

Why IAQ is Important to Your School

Most people are aware that outdoor air pollution can damage their health, but many do not know that indoor air pollution can also cause harm. Environmental Protection Agency (EPA) studies of human exposure to air pollutants indicate that indoor levels of pollutants may be 2-5 times, and occasionally more than 100 times, higher than outdoor levels. These levels of indoor air pollutants are of particular concern because it is estimated that most people spend about 90% of their time indoors. Comparative risk studies performed by EPA and its Science Advisory Board have consistently ranked indoor air pollution among the top four environmental risks to the public.

Failure to prevent indoor air problems, or failure to act promptly, can have consequences such as:

- increasing the chances for long-term and short-term health problems for students and staff
- impacting the student learning environment, comfort, and attendance
- reducing productivity of teachers and staff due to discomfort, sickness, or absenteeism
- faster deterioration and reduced efficiency of the school physical plant and equipment
- increasing the chance that schools will have to be closed, or occupants temporarily moved
- straining relationships among school administration and parents and staff
- creating negative publicity that could damage a school's or administration's image and effectiveness
- creating potential liability problems

Indoor air problems can be subtle and do not always produce easily recognized impacts on health, well-being, or the physical plant. Children are especially susceptible to air pollution. For this and the reasons noted above, air quality in schools is of particular concern. Proper maintenance of indoor air is more than a "quality" issue, it includes safety and good management of our investment in the students, staff, and facilities.

***Good indoor air quality** contributes to a favorable learning environment for students, productivity for teachers and staff, and a sense of comfort, health, and well-being for school occupants. These combine to assist a school in its core mission — educating children.*

Understanding IAQ Problems and Solutions

Over the past forty or fifty years, exposure to indoor air pollutants has increased due to a variety of factors, including the construction of more tightly sealed buildings, reduced ventilation rates to save energy, the use of synthetic building materials and furnishings, and the use of chemically-formulated personal care products, pesticides, and housekeeping supplies. In addition, our activities and decisions, such as delaying maintenance to "save" money, can lead to problems from sources and ventilation. Four basic factors affect IAQ: sources of indoor air pollutants, the heating, ventilation, and air-conditioning (HVAC) system, pollutant pathways, and occupants.

Sources of Indoor Air Pollutants

Indoor air contaminants can begin within the building or be drawn in from outdoors. If pollutant sources are not controlled, IAQ problems can occur, even if the HVAC system is working properly. Air pollutants consist of numerous particles, fibers, mists, molds, bacteria, and gases. It may be helpful to think of air pollutant sources as fitting into one of the categories in the table shown below.

In addition to the number of potential pollutants, indoor air pollutant levels can vary within the school building, or even a single classroom. Pollutants can also vary with time, such as only once each week when floor stripping is done, or continuously such as when fungi is growing in the HVAC system.

HVAC System Design and Operation

The heating, ventilation, and air-conditioning (HVAC) system includes all heating, cooling, and ventilating equipment serving a school. A properly designed and functioning HVAC system:

- controls temperature and humidity to provide thermal comfort
- distributes adequate amounts of outdoor air to meet ventilation needs of school occupants
- isolates and removes odors and pollutants through pressure control, filtration, and exhaust fans

Not all HVAC systems are designed to do all of these things. Some buildings rely only on natural ventilation. Others lack cooling, and many have little or no humidity control.

Pollutant Pathways and Driving Forces

Airflow patterns in buildings are caused by mechanical ventilation systems, human activity, and natural effects such as wind. Air pressure differences created by these forces move airborne pollutants from areas of higher pressure to areas of lower pressure through any available openings in building walls, ceilings, floors, doors, windows, and HVAC system. An inflated balloon is an example of this driving force. As long as the opening to the balloon is kept shut, no air will flow, but when open, air will move from inside (area of higher pressure) to the outside (area of lower pressure). Even if the opening is small, air will move until the pressures inside and outside are equal.

Typical Sources of Indoor Air Pollutants

Outside Sources

Polluted Outdoor Air

- pollen, dust, fungal spores
- industrial emissions
- vehicle emissions

Nearby Sources

- loading docks
- odors from dumpsters
- unsanitary debris or building exhausts near outdoor air intakes

Underground Sources

- radon
- pesticides
- leakage from underground storage tanks

Building Equipment

HVAC Equipment

- microbiological growth in drip pans, ductwork, coils, and humidifiers
- improper venting of combustion products
- dust or debris in ductwork

Non-HVAC Equipment

- emissions from office equipment (volatile organic compounds, ozone)
- emissions from shops, labs, cleaning processes

Components/Furnishings

Components

- microbiological growth on soiled or water-damaged materials
- dry traps that allow the passage of sewer gas
- materials containing volatile organic compounds, inorganic compounds, or damaged asbestos
- materials that produce particles (dust)

Furnishings

- emissions from new furnishings and floorings
- microbiological growth on or in soiled or water-damaged furnishings

Other Indoor Sources

- science laboratories
- vocational arts areas
- copy/print areas
- food preparation areas
- smoking lounges
- cleaning materials
- emissions from trash
- pesticides
- odors and volatile organic compounds from paint, caulk, adhesives
- occupants with communicable diseases
- dry-erase markers and similar pens
- insects & other pests
- personal care products

Building Occupants and Health

Building occupants in schools include the staff, students, and other people who spend extended periods of time in the school. The effects of IAQ problems on occupants are often vague symptoms rather than clearly defined illnesses. Symptoms commonly attributed to IAQ problems include:

- headache, fatigue, and shortness of breath
- sinus congestion, cough, and sneezing
- eye, nose, throat, and skin irritation
- dizziness and nausea

All of these symptoms, however, may also be caused by other factors, and are not necessarily due to air quality problems. Environmental stressors such as improper lighting, noise, vibration, overcrowding, and psychosocial problems (such as job or home stress) can produce symptoms that are similar to those associated with poor air quality, but require different solutions.

Because people are different, one individual may react to a particular IAQ problem while surrounding occupants have no noticeable ill effects. In other cases, complaints may be widespread. In addition to different degrees of reaction, an indoor air pollutant or problem can trigger different types of reactions in different people. Some groups that may be particularly susceptible to effects of indoor air contaminants include:

- allergic or asthmatic individuals, or people with sensitivity to chemicals
- people with respiratory disease
- people whose immune systems are suppressed due to radiation or chemotherapy, or disease
- contact lens wearers

Six Basic Control Strategies

There are six basic methods for lowering concentrations of indoor air pollutants. Specific applications of these methods are noted in the *Indoor Air Quality Tools for Schools* Kit (see the back page for information on the Kit).

Source Management includes source removal, source substitution, and source encapsulation. Source management is the most effective control method when it can be practically applied. The best prevention method is never to bring unnecessary pollutants into the school building. Examples of source removal include not allowing buses to idle near outdoor air intakes, not placing garbage in rooms where HVAC equipment is located, and banning smoking within the school. Source substitution includes actions such as selecting less toxic art material or interior paint than the products which are currently in use. Source encapsulation involves placing a barrier around the source so that it releases fewer pollutants into the indoor air.

Local Exhaust is very effective in removing sources of pollutants before they can be dispersed into the indoor air, exhausting the contaminated air outside. Well known examples include restrooms, kitchens, and science lab fume hoods. Other examples of pollutants that originate at specific points and that can be easily exhausted include science lab and housekeeping storage rooms, printing and duplicating rooms, and vocational/industrial areas such as welding booths.

Ventilation uses cleaner (i.e., outdoor) air to dilute the contaminated (i.e., indoor) air that people are breathing. Generally, local building codes specify the amount of outdoor air that must be continuously supplied to an occupied area. For situations such as painting, pesticide application, or chemical spills, temporarily increasing the ventilation can be useful in diluting the concentration of fumes in the air.

Exposure Control includes the principles of time of use and location of use. An example of time of use would be to strip and wax floors on Friday after school is dismissed, so that the floor products have a chance to release gases over the weekend, reducing the level of odors or contaminants in the air when the school is occupied. An example of location of use involves moving the contaminating source as far as possible from occupants, or relocating susceptible occupants.

Air Cleaning primarily involves the filtration of particles from the air as the air passes through the ventilation equipment. Gaseous contaminants can also be removed, but usually this type of system should be engineered on a case-by-case basis.

Education of the school occupants is critical. If school staff are provided information about the sources and effects of contaminants under their control, and about the proper operation of the ventilation system, they will better understand their indoor environment and can act to reduce their personal exposure.

Appendix B

KENSINGTON PARKWOOD ELEMENTARY SCHOOL CASE STUDY

Introduction

This case study was prepared by a member of this process action team (PAT), who has undertaken an independent information gathering effort. The information contained in this case study is not reflected in the files of Montgomery County Public Schools (MCPS) Divisions of Maintenance, School Plant Operations (SPO), or Safety and Environmental Health Unit's (SEHU). The information presented in this case study is an expansion of information presented to the indoor air quality (IAQ) process action team (PAT), and focuses primarily on events beginning with the 1997-98 school year, although historic information is included where available and pertinent.

Kensington Parkwood Elementary School (KPES) is located in Kensington, Maryland. KPES was constructed in approximately 1952 and was last renovated around 1970. The school has a relatively stable school population of around 350 students.

KPES has been experiencing mold and fungal contamination problems for more than a decade, as described by teachers and parents. Because many journal publications have established a link between mold and childhood respiratory problems, the PAT has recognized that the procedures MCPS employs for dealing with mold related problems are very important. This case study describes the process that took place to address and resolve these problems. Although SEHU states that all cases are investigated on an individual basis, this case study is intended to give insight into the parents' view of the processes that occurs in the Montgomery County Public School (MCPS) system when addressing indoor air quality (IAQ) issues and illustrates the areas where improvements are warranted.

Initial Problem Presentation: Week Prior To School Opening

In the week prior to the opening day for the 1997-1998 school year, staff at KPES found mold in two of the classrooms (Rooms 1 and 3). According to the staff, the mold, black and green in appearance, covered large parts of the walls, shelves, furniture, counters and toys, and according to staff, emanated an extremely strong odor. These two rooms were designated for use by the YMCA for before/after school care, Kindergarten enrichment, and preschool. For two days the YMCA staff cleaned the rooms and all its contents. They threw away all of the children's dress up clothes and shoes, and many toys due to mold contamination. During normal preparation for school opening, the YMCA program director and another YMCA employee were cleaning the rooms and experienced severe respiratory distress. They both claimed that while in the rooms, their chests tightened and it became very difficult to breathe.

While cleaning on August 28th, the YMCA staff and the KPES Building Service Manager (BSM) discovered that the fan blades of the wall unit ventilators (UV) were coated with mold and the UVs emitted a strong moldy odor even after cleaning. Concluding that this was a more severe problem than they were comfortable dealing with, the BSM contacted SEHU, and the secretary told him that someone

would call him back. SEHU returned his call the next day and told the BSM to fill out the proper forms (230-23 and 230-24) and someone would respond as soon as possible.

Investigation and Mitigation of Problems by MCPS

The next day, Friday, August 29th, the KP principal made a formal request to MCPS SEHU for an air quality and mold/mildew inspection. The following Wednesday, September 3rd, SEHU sent a representative[1] to inspect the rooms (SEHU's sole regular field investigator was investigating an IAQ issue at Belmont Elementary School). According to SEHU, the representative is a part of the emergency response team, and he was asked to go to the site as a Facilities Management representative to do an initial assessment of mechanical and ventilation systems and to gather any relevant information. According to the YMCA program director, the representative said the rooms needed to be aired out. Meanwhile, the YMCA staff had been keeping the windows opened for over a week to dissipate the mildew and cleaning odors. The next day, Sept. 4th, the SEHU field investigator conducted a site visit. He did a visual check and took some air quality measurements with a hand-held instrument. According to the YMCA director, he declared to her that "the air in the rooms was fine." According to SEHU, the field investigator stated to KPES staff that his initial measurements of temperature, relative humidity, carbon-monoxide, and carbon-dioxide were within normal ranges. He further stated that he saw no need for immediate concern, but he did see a need for remediation.

After the inspection, and certain that the rooms were not "fine," the YMCA director spoke with the principal, stating that she was still experiencing symptoms when in the two classrooms. According to the YMCA director, the principal said, "You are just over-sensitive. Everything is okay in Room 1." A day or two later, when the YMCA director again voiced her concern, the principal responded that the field investigator had now said that indeed both rooms 1 and 3 had now been found to contain mold and fungi.

The regional YMCA director contacted the KP principal to discuss the problem. They decided that the pre-school (Room 3) opening would be postponed until the mold problems were corrected, but the after school care would be relocated to the All Purpose (AP) room. When contamination was found in Room 1, the programs housed in that room (before and after school program and the Kindergarten enrichment) were also relocated to rooms designated by the principal.

Unfortunately, the alternative rooms had problems of their own. Room 4 (the Reading Room) also had severe mold infestation. Another room, the AP room was having a mural painted on a wall by a parent. Painting occurred during normal school hours, usually with the windows and door closed and while other activities were taking place in that room, including physical education classes and school lunches. According to YMCA staff, many children complained about headaches, odors and irritated eyes. When the author asked the parent-painter what types of paint she was using, she responded that they were Crayola water-based wall paints, and were completely non-toxic, but she no longer had the paint cans. She said, "they are so safe, you could even eat them." However, all wall paints rely on solvents, which invariably have adverse health effects, and paint cans advise painters to have adequate ventilation. SEHU was not aware and had approved the use of these paints.

[1] This individual is an employee of the Facilities Management Division, the same Division that includes SEHU. This individual had no training in the relevant health, environmental and air quality disciplines.

September 8 through September 12

Sometime later, SEHU discovered that the condensate pan in the Room 1 unit ventilator was overflowing onto the carpet. As a result of SEHU recommendations, a maintenance crew removed, cleaned, and reinstalled the unit ventilators and surrounding shelves in rooms 1 and 3. They found and removed old carpeting under the unit ventilators orphaned from previous carpet removals/installations. The maintenance personnel found that the condensate drain pipes for both unit ventilators were clogged, and the condensate collection pans were filled with years of collected moldy crud. According to the KPES principal and staff, on Friday morning, Sept. 12, room 3 was inspected by the SEHU Specialist and found to be

> *"odor and mildew free. Room 1 would require complete carpet removal with tile replacement in order to eliminate the remaining moldy odor."* [2]

The SEHU field investigator claims he stated only that the room was odor free, never mentioning that there was no mold or mildew. At this point, the room was being used as an instructional space.

September 12: Case-Study Author Involvement

It was about this time that the author of this case study (hereafter referred to as "the author") was asked to get actively involved by several parents and the YMCA staff. While assessing the situation, the author entered room 3, where the Kindergarten Enrichment class was in session. He found a teacher holding her chest, seemingly gasping for air. "Are you alright?" he asked. "No," the teacher replied, "I am having trouble breathing. I am very sensitive to allergens and I am having an allergic reaction." The author had never met her and she had no knowledge of his involvement in this process. The author then introduced himself. The teacher told him that although the units were now cleaned, and she thought it was better in the room, she was still reacting to the mold. She also told him that several of her students had unexplained, persistent coughs since the beginning of the school year. An MCPS full-time instructional aide also experienced a severe respiratory response when working in room 4. She said that while in the room, her throat immediately got scratchy and sore, and after a while her "throat closed up." Upon leaving the room, her symptoms diminished. The YMCA director, who all along had been having severe respiratory reactions, sought out and received health evaluations from two physicians. The first, from the YMCA director's physician, a general practitioner, wrote that the YMCA director is

> *"under my care for breathing difficulties. It appears that there is a strong suggestion of occupational exposure to chemicals and/or airborne molds that are contributing significantly to her symptoms."*[3]

The second, an allergy/pulmonary specialist who examined the YMCA director, stated, that

> *"clearly, the mold growth in her classroom is having a negative impact on her health."*[4]

Evidence of Historical Elements of Problem

During the author's investigation, a teacher and the BSM described a series of events that pointed out the persistent nature of this problem, and said that they continued to find mold on the chairs and furniture in the mornings. Often, tape would not stick to the

[2] Letter from Kensington Parkwood Elementary School principal to parents, dated September 12, 1997.

[3] Letter from the YMCA director's physician, dated September 17, 1997

[4] Letter from YMCA director's allergy/asthma specialist to the director's physician, dated September 25, 1997.

walls because they were too damp. Although this investigation was cursory, plenty of evidence of moisture and mold remaining in the school was found. The author also sensed an extreme level of frustration among some parents and staff because of what they viewed as inadequate and inappropriate response by MCPS. When the author mentioned some of the issues to the SEHU director at the PAT meeting, she expressed concern and immediately arranged for SEHU's field investigator to meet me at the school to conduct a thorough investigation.

September 15: Walkthrough

SEHU's field investigator, the KPES BSM, another KPES parent, and the author conducted a thorough walk-through of the school. We found significant evidence of school wide moisture problems including the following:

- Rooms had musty smells. Damp carpet.
- Baseboards had moldy growth.
- Soil outside the rooms was higher than the inside floor elevation; poor drainage with depressions allowed for ponding near exterior wall.
- Many condensate drain pipes from unit ventilators were flush with exterior walls, and stains on the walls occurred from condensate drainage.
- Rooms 2 and 4, three basement rooms, and the media center had particularly strong moldy odors.
- Unit ventilator in Room 4 was leaking onto floor as a result on uninsulated supply pipes. The carpet was wet.
- Ceiling panels surrounding the exhaust fan in the hallway by the science room were discolored and wet around the edges.
- Exhaust fans located in the hallways have not functioned for many years.
- Within the previous year, the condensate pipe in a room on the second floor had been clogged and had leaked through the floor into the lower level Kindergarten room below.
- Within the previous year, toilets had overflowed on the upstairs and lower levels, also flooding the lower level Kindergarten room.
- A few teachers complained of moldy smells near the unit ventilators.
- Several teachers stated that prior to the current BSM, the accessible parts of the unit ventilators had not been cleaned, nor had the filters been changed. The BSM stated that filters had not been ordered at KPES for many years prior to his assignment (1 1/2 years ago).
- The media center director informed me that she has to occasionally throw away moldy books. These books are usually located along the outside wall.

It was clear that there was a widespread moisture and mold problem in Kensington Parkwood, not isolated to rooms 1 and 3. It was also clear that this was a long-term maintenance problem that wouldn't be corrected with the few recommendations by SEHU. Additionally, initial recommendations by SEHU were primarily addressing the symptoms and not the causes of the problem.

The author discussed the problems with SEHU's field investigator and together we formulated a list of actions to be taken:

- Remove and replace carpets with tile in rooms 2, 3, and 4 (in addition to room 1 which was already recommended, but not yet done).
- Clean all unit ventilators properly to correct the clogged condensate pipes; clean the moldy substances from the collection pans.
- Extend condensate pipes away from the building.
- Re-grade ground adjacent to building to provide proper drainage of rain and condensate away from exterior walls.
- Trim trees to allow more sunlight to reach the building and thereby dry it out. (It was noted that there had been an MCPS work order on file for tree trimming at KP for over a year.)
- Routinely clean and check gutters and downspouts to ensure they are free of obstacles.
- Check roof for leaks, where there were obvious signs of moisture in ceiling tiles.
- Check for condensate and other sources of moisture where ceiling tiles were stained.
- Repair exhaust system so that it functions according to original design.
- Clean shrubs and other growths from in front of air intakes.

For the next three weeks, no remedial actions were undertaken, nor was any further information forwarded to the parents. The pre-school had opened, and some pre-school parents mentioned that their children developed persistent coughs at the opening of school. The after-school and kindergarten enrichment kids continued to be displaced into other rooms (waiting for the carpet to be replaced in room 1). The YMCA staff and parents became extremely frustrated at the lack of progress by MCPS.

Division of Maintenance Involvement

On October 8th, the Director of the Division of Maintenance arrived at the school and informed the principal of plans to remediate the mold problems. His presence occurred the morning after the KPES mold problem was presented to the entire IAQ PAT, on which he serves. This is the first time the Director of Maintenance was made aware of the seriousness of this problem, as described below. Within one week, all unit ventilators had been dismantled and cleaned, carpets in rooms 2, 3, & 4 had been removed and replaced with tiles, and all impacting trees had been trimmed.

During this week, the author visited the school after hours to check on the cleaning/remediating activities. There were four men on the job of cleaning the school's unit ventilators. They dismantled each unit and vacuumed and sprayed accessible components (including the coils, the fan blades, the condensate pans, etc.) with a detergent solution via a pressure tank. They used the detergent spray device to try to clean the clogged condensate pipes that went from the unit to the outdoors. According to the BSM, approximately three quarters of the condensate pipes in the building were completely clogged. In order to get them opened, the men poked an outstretched coat hanger through them, followed by spraying from both sides. Although they managed to unclog the pipe sufficiently to generate a small stream of water, it appeared that the pipes were only partially open.

In the Kindergarten room, the unit ventilator contained a beehive, and the condensate drainpipe served as the bees' pathway into the unit ventilator. Condensate pipes were often found filled with sticks and other debris. In one case, the entire condensate pipe was buried under a flowerbed that the PTA had constructed. In the band/music room, the condensate pan was sloped away from the drain, with liquid overflowing before flowing through the drain.

All of the drip pans in the school were laden with a layer of biological film. Sheet metal guides that ran the length of the UV were corroded and also covered with crud. The crew felt these items were unusable and decided to discard them. Since the location of the operating manual to these units is not known, the question remains as to the purpose of these guides. As of February, 1998, they have not been replaced. Also, a rectangular fiberglass fabric that sealed and lined the front of each unit was infested with mold. According to the BSM, before my visit, an SEHU consultant (Vice President of Aerosol Monitoring and Analysis, Inc. (AMA)) had instructed the crew to throw them all away. The author suggested to the head of maintenance that without knowing the intended purpose of these pads, this might be a mistake. He agreed and told the BSM not to remove these pads. It was later hypothesized that these pads served multiple functions: thermal insulation, noise insulation, and sealing the opening to prevent airflow. Without these pads, it is possible that these units posed a burn hazard to the children.

Results

During the weeks following remediation, the majority of the teachers and parents involved commented that the indoor air was greatly improved. However, one teacher continued to experience slight respiratory distress while in rooms 1 and 3.

MCPS contracted with AMA to perform a microbial indoor air quality evaluation at KPES. This study was conducted on October 31, 1997 and a report was prepared and submitted to MCPS on December 15, 1997. The air samples showed somewhat elevated levels of microbes in the air in rooms 1 and 3, indicating there were still significant microbial sources present. Although very few samples were taken, the wipe samples indicated that the source was likely in and around the unit ventilators. Two of the four wipe samples in room 3 generated mold cultures that could not be quantified due to overgrowth of bacteria. The two wipe samples inside the unit ventilator in room 1 could also not be quantified due to confluent growth of fungus in one case and overgrowth of bacteria in another case. The air samples in rooms 2 and 4 showed low airborne spore concentrations. However the wipes also indicated some microbial activity in the unit ventilators. These results provide strong evidence that the unit ventilators are still harboring a moisture rich environment encouraging microbial growth.

The AMA report made four recommendations in response to their findings. The recommend-ations were echoed as items in a memo from the Director of the Department Facilities Management to the KPES principal. The four recommendations along with the MCPS responses and actions taken are as follows:

1. Unit ventilator filters

AMA RECOMMENDATION: The unit ventilators need to have their filters changed on a frequent enough basis to prevent substantial build-up of dust and microbial growth. Filters should be changed in accordance with MCPS policies.

MCPS RESPONSE: Division of School Plant Operations personnel are to ensure that the filters of all unit ventilators are changed on a quarterly basis in accordance with current MCPS policy.

MCPS ACTION: None.

CRITIQUE: Since the MCPS instruction is to follow current policy, the implication is that the current policy has not been adhered to in the past. MCPS has not made a change to ensure that current policy will be better followed, and therefore, this instruction is unlikely to produce genuine change. Another possible interpretation of the AMA recommendation is that the filters need to be changed more frequently. MCPS apparently has no plans to examine this possibility.

2. Unit ventilator cleanliness

AMA RECOMMENDATIONS: Unit ventilators need to be cleaned and sanitized more thoroughly. Effective cleaning requires disassembly of the unit, i.e., opening internal panes to the coils and outside air dampers, and pulling the unit out of the housing if its design permits that. In addition, proper sanitizing products are needed. The cleaning/sanitizing should be performed on a frequent enough basis to prevent excessive build-up of dust, debris and rust on internal surfaces.

The fiberglass insulation lining the cover panels needs to be removed under controlled conditions and replaced with new insulation.

MCPS RESPONSE: Division of School Plant Operations, Division of Maintenance, and the Safety and Environmental Health Unit will schedule the unit ventilators in classrooms 1 through 4 to be recleaned during the month of January 1998.

MCPS ACTION: According to a memo from the KPES principal to the affected staff, the unit ventilators in rooms 1 through 4 were recleaned on Saturday, January 17. The fiberglass insulation linings were replaced on the unit ventilators in rooms 1 through 4 over the weekend of February 21, 1998.

CRITIQUE: Based on the MCPS response, it is not known whether the units were disassembled, properly cleaned and sanitized as recommended by their consultant. Since the first cleaning proved to be inadequate, the rooms need to be re-evaluated following this round of remedial actions. No mention is made of plans to implement more frequent cleaning and sanitizing as recommended by their consultant.

Even though the unit ventilators in the entire school were found to be in similar condition as those in rooms 1 through 4, there are no plans to evaluate or replace fiberglass insulation linings in the rest of the school.

3. Refrigerator condensate pan

AMA RECOMMENDATIONS: The refrigerator's condensate pan should be regularly cleaned by the housekeeping staff to prevent substantial build-up of dust and microbial growth.

MCPS RESPONSE: Division of School Plant Operations personnel are to ensure that the coils and condensate pan of the refrigerator are regularly cleaned and sanitized.

MCPS ACTION: Unknown

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4. Mold on wood paneling

AMA RECOMMENDATIONS: The microbial growth at the bottom of the wood paneling in classroom 3 should be disinfected with a 10% chlorine bleach solution on a frequent enough basis to control growth. If this action does not control growth, then the wood paneling should be removed and replaced with new paneling.

MCPS RESPONSE: Division of School Plant Operations personnel are to treat the affected area with a 10% bleach solution on a weekly basis. If this does not control the growth, the wall will be replaced.

MCPS ACTION: Unknown

CRITIQUE: The MCPS response does not provide a means for evaluating whether the growth has been controlled. Additionally, if the prescribed treatment is implemented and it results in the wall being partially saturated on a weekly basis, MCPS may be unknowingly exacerbating the problem. While the solution is likely to kill the mold it comes into contact with, the chlorine volatilizes long before the wall dries. This may leave a situation ideal to begin new mold growth.

Interpretation and Evaluation of Events Analysis

The recent mold problems at KPES ultimately originated from a long-standing lack of preventive maintenance, resulting in improperly functioning mechanical and drainage systems, and poor control of moisture at the building envelope. These conditions combined to create an indoor environment of excess moisture ideal for mold growth, and consequently a potential threat to the health of our children and teachers. . These same conditions exist in much of the rest of the school. However, MCPS has no plans to do further evaluations and mitigation unless further complaints are filed.

Although the presence of mold in the affected classrooms was visibly obvious and odorous, neither SEHU nor the Division of Maintenance acted in a timely manner nor did they address the problem with credible solutions. This is evidenced by the passage of more than 1? months between the report of the problems and serious remedial efforts such as replacing the carpet and cleaning the unit ventilators. It was obvious that this process was accelerated by my presence on the PAT. During the weeks leading up to the remedial actions, the seriousness of the problem was downplayed repeatedly. It was apparent that the methods used by MCPS for resolving these problems addressed only the symptoms and were unlikely to discover and rectify the root causes. Additionally, a lack of forthcoming communication and the minimization of the problem's seriousness perpetuated frustration within the school community.

<u>Timeliness of Response</u>

Following discovery of the mold, the YMCA staff spent 3 days cleaning prior to reporting the problem to the BSM who subsequently reported it to SEHU. SEHU's first response was to send a facilities management representative, who had no training in the relevant health, environmental and air quality disciplines. SEHU's field investigator visited the next day and started the process of recommending work orders. As a result, sporadic efforts were undertaken by maintenance personnel over the next two months (approximately). This response demonstrates either a lack of understanding of the scope of this problem or a lack of

commitment in finding a solution. Never was a coordinated effort undertaken to systematically identify the cause of the problem, develop and implement a coordinated solution, and verify that the problem had been adequately mitigated. MCPS's lack of commitment to finding a solution is also evidenced by communications from SEHU to KPES staff, repeatedly indicating that there was no reason to be concerned. Furthermore, SEHU appeared to avoid communication with affected staff and students, rather than seek communication as part of their efforts.

MCPS's response was very slow, particularly when the problems were impacting the health of the children and staff, as they did in this case. Apparently, SEHU does not have a formal process through which they rank the seriousness of complaints, and mold is not treated as a serious problem. This results in delayed responses. Also, in light of the fact that a tree-trimming work-order had been in place for over one year, it is clear that the procedures for handling work-orders are inadequate.

<u>Approach to Problem was Palliative not Diagnostic</u>

The foregoing suggests that the approach to this problem was to attempt to find a short-term fix rather than to perform a serious diagnosis that would lead to a true resolution of the problem. Evidence for this includes:

- On September 4th, after the rooms were scrubbed with a Clorox solution as recommended by the facilities management representative, the SEHU field investigator conducted a site visit. According to the YMCA director, he visually examined the rooms, took measurements with a hand-held instrument, and declared that "the air in the rooms was fine" for the opening of the pre-school. SEHU claims that they stated only that measurements of carbon monoxide, carbon dioxide, relative humidity, and temperature were normal. Since the problem was clearly mold related, the hand-held instrument provided only peripheral information and should not have been used to imply that there wasn't a problem. The instrument had no ability to detect the presence of mold or its bio-effluents. The fact that the rooms were later shown to be mold infested indicates that the statement about the air quality was misleading.
- After the unit ventilators were dismantled and cleaned, room 3 was re-inspected by SEHU on September 12th. The principal asked SEHU to assess whether the rooms were safe for children. According to the principal, SEHU stated that the rooms were "odor and mildew" free, this, despite ongoing complaints from YMCA staff. However, according to the BSM, mold continued to reappear on the furniture and shelves each subsequent morning. (Because of SEHU's assessment, the principal reached the conclusion that the classrooms could return to normal use.)
- The initial SEHU instructions were to sanitize the rooms with a Clorox solution. Only when the mold reappeared repeatedly did SEHU investigate further. At this point, SEHU concluded that the problem was due to an overflowing condensate pan of the unit ventilator.
- The carpet around the unit ventilator in room 1 was found to be saturated as a result of the overflowing condensate pan, and was identified as seriously mold infested.
- There was obvious wide spread evidence of water and mold at KPES. Only after the author pointed out the seriously under-maintained condition of the ventilation equipment was a school wide cleaning effort initiated. During the cleaning effort, it was found that approximately three of every four unit ventilators had clogged condensate drains and every unit ventilator had evidence of mold growth. The crucial point is that the SEHU field investigator failed to uncover the extent of the problems in rooms 1 and 3, and similar problems in the rest of the school.

Each of these events illustrates problems in the diagnosis and remediation these mold related problems. When confronted with evidence of mold in the unit ventilators in rooms 1 and 3, SEHU did not follow up on the obvious likelihood that the unit ventilators in the rest of the school would be in similar condition. Evidently, the problem identification and mitigation events occurred despite, not because of, SEHU. Given that this room was used for care of pre-school children who spent a significant amount of time on the floor, SEHU's initial assessment that the rooms posed no danger to the children and could resume normal use was inadequate because it did not find the actual problem. It is apparent that the investigations were not adequately thorough, and that SEHU would have declared the rooms "fine" without persistent outside pressure. In addition, suggestions to prevent future problems of this nature, such as designing devices that prevent children from putting sticks inside condensate drains, were not suggested by SEHU and would likely never be implemented by MCPS.

It is evident that, at the time, SEHU did not have in place an adequate set of criteria for assessing the urgency of mold infestation problems.

Division of Maintenance Issues

Ultimately, these mold problems at KP result from improper installation, operation, and maintenance. The existence and use of a Building Maintenance Plan is vital for proper maintenance of virtually any building. Such a plan is necessary whenever mechanical equipment is repaired or evaluated for proper functionality, as well as to insure that proper, regularly scheduled maintenance is performed. As far as could be determined, there is no Building Maintenance Plan for KPES or any other MCPS school.

When the unit ventilators were installed, they were placed over existing carpets. When the carpets were later replaced in the rooms, the old carpet pieces were cut around and left under the unit ventilators, resulting in old, wet, moldy carpet. Carpet should never have been placed beneath unit ventilators since by design, unit ventilators condense water into the drip pan.

Similarly, other improper installation techniques likely contributed to the mold growth. During the inspection, we found a drip pan that was sloped the wrong way, meaning that the entire pan had to fill up with condensate before the water could flow out the pipe. This allowed water to sit and stagnate in the pan for years, a potential breeding ground for mold, fungi and bacteria. This is very undesirable since outside air passes over the pan as it enters the room.

Numerous other examples of construction practices impacting indoor air quality are also present. For example, the ventilation system and intake for the cafeteria kitchen is housed in the tractor shed. The kitchen staff continuously complains of gas fumes. Formal complaints have been filed numerous times to SEHU over the past few years (the last one 5/5/97). As of February 1998 nothing has been done to remedy this problem. Furthermore, various storage spaces in the school have been converted to offices (for example, the counselor's office and the BSM office). These spaces were never intended for their current use. Although both rooms have been fitted with heating units, they are not supplied with fresh air.

It is likely that many of the school's mold problems would have been avoided if regular and appropriate preventive maintenance had been conducted on the school's unit ventilators and plumbing and drainage systems. Although MCPS' current policy is to change the air filters four times a year, these

filters had not been ordered or changed for many years prior to the assignment of the current BSM (August 1997) to KPES. Many of the mechanical components of the unit ventilators routinely come in contact with water and require regular cleaning. Also, to function as designed, the mechanical components, such as the dampers, require regular adjustments. These maintenance and cleaning functions have not been performed for many years, quite possibly since installation. Other routine practices contribute to mold related problems. For example, until the purchase of a new carpet shampooing machine a few months ago the carpets in KPES were shampooed with a machine that applied water and soap to the floor, but did not have an extractor to remove the water. Subsequent to shampooing, the water sat in the carpet. According to the BSM, he was never advised to open the window or take any other action to help dry out the carpet after shampooing. This neglect of essential operation and maintenance details demonstrates a lack of oversight, training, and ultimately commitment to preventive maintenance.

As far as could be determined, there are no manuals kept at the school describing the proper operation of the ventilation equipment. Therefore, the workers had no way of determining the proper function or operating parameters of the various mechanical components. When the workers found, in every unit ventilator, a component corroded to the point where it could no longer be used, believing it served no useful function, they made the decision to discard the component. Although the intended function is still unknown, it has been hypothesized that the purpose of the component is to guide condensate into the drip pan. The degree to which the components were corroded indicates that the components were in frequent and prolonged contact with moisture. Since this component is no longer in place in any of the unit ventilators, it is likely that moisture is not being properly collected and drained. As a part of the cleaning, no attempt was made to verify the correct operation of all components of the unit ventilators. These events further demonstrate the haphazard approach to dealing with these problems, and that no division within Facilities Management adequately oversees the mitigation efforts.

In another case reported by the BSM, the Vice President of AMA instructed the BSM to remove the fiberglass pad inside the front cover of the unit from all the unit ventilators in the school because it was mold infested. During a meeting that included the director of the Division of Maintenance, the BSM, and myself, the author asked if anyone considered the intended function of these pads. The BSM said the consultant claimed they served no function. The author suggested that these pads should not be discarded until their intended purpose was understood to prevent from creating a more dangerous situation. The director of the Division of Maintenance agreed and ordered that the pads not be discarded. Although it has not been confirmed, it was later hypothesized that these pads may serve the following three functions: 1) to seal the front opening to prevent air from coming out in unintended locations; 2) noise insulation; and 3) heat insulation. By removing these pads, it is possible that a potentially dangerous situation could have been created; the front cover of these units could have reached temperatures that would cause burns. During the heating season, the temperature of water leaving the boiler plant is between 180 and 200 ^{o}F, according to information provided by SEHU. It is unknown whether the front panels, if uninsulated, would reach a temperature in excess of 120 ^{o}F (approximate scalding). SEHU stated that AMA does not have the authority to effect this type of action without SEHU approval, which AMA did not have in this case.

Numerous other events demonstrate the perpetuation of these problems. During a recent rainstorm, the author observed the downspout located in the rear of the building producing a parabolic stream of water from a hole about 3 feet off the ground. The stream of water, landing approximately 5 feet horizontally from the downspout, indicated that the height of the water in the downspout was at least several feet above the hole, and that the downspout is clogged. Since the gutters and downspouts were supposedly cleaned during the mitigation efforts, this calls into question other supposedly completed tasks.

Another example is the hallway exhaust fans throughout the school, which are disconnected and nonfunctional. Although Facilities Management recommended the operational status of these be reviewed in their memo of October 1, 1997, the fans still do not function. The inoperable dampers on the unit ventilators are also mentioned in the Facilities Management memo. The memo recommends that the Division of Maintenance "develop a schedule to dismantle, clean, disinfect, and ensure the proper operation of the building's unit ventilators." The proper operation may have been achieved in rooms 1 and 3, but has not been addressed throughout the school. These illustrative examples demonstrate that Facilities Management currently does not have a formal method of fulfilling their recommendations to divisions under their control. It appears that Facilities Management often issues recommendations to their own divisions, but does not require satisfactory completion of the stated recommendations.

Communication

Communication from MCPS to the school community about health and indoor quality issues during events subsequent to the discovery of the mold problems was noticeably absent and incomplete. Staff and parents were not told in a timely manner accurate information related to any possible health hazards to which they or their children may be exposed. Forthcoming communication provides benefits for both MCPS and the school community. If genuine and credible investigation and mitigation efforts were applied to a problem, appropriate communication would make the community aware of the efforts, prevent misunderstandings, and provide a forum for feedback.

By relaying complex technical information to the community through the principal and relying on the principal to correctly interpret and communicate that information, SEHU places a buffer between themselves and the community and fosters situations that can lead to frustrations and misunderstandings. Examples of these communication difficulties are presented below.

The school community was first officially notified of the mold problems found in the school nearly two weeks after the start of school in a letter (dated Sept. 12, 1997) from the principal. The letter memo stated that:

> *"Room 3 was reinspected by the Health and Safety Specialist and found to be odor and mildew free. Room 1 will require complete carpet removal with tile replacement in order to eliminate the remaining moldy odor. This work is being scheduled for early next week."*

While SEHU disputes that they said that the room was "odor and mildew free" but claims they said only the room was "odor free," the principal clearly had the impression that SEHU was declaring the problems in Room 3 resolved. Regardless of the exact statement, the complainants did not agree with SEHU's assessment, still felt there was a problem, and that SEHU was not taking their complaint

seriously. In the view of the room occupants, the mold problem actually persisted at least until the middle of October, when the carpet was replaced with tile, with at least one individual still having adverse reactions.

The school principal was placed in the awkward position of conveying information to the community that was later proven to be incorrect: the letter of September 12th stated that "*this work is being scheduled for early next week"* when in fact the work was not scheduled. When questioned, the principal said that SEHU's field investigator had told her that he was going to forward his recommendations to maintenance, and that work would probably get started the next week. She interpreted this as that it was scheduled for the following week. According to the director of the Division of Maintenance, he was unaware of work orders for replacement of the carpet as of September 15th. Since at that time, maintenance had not agreed to this schedule, this communication was misleading. In fact, the work was started more than a month later.

Throughout the IAQ events at KP, the affected individuals were not included as part of the solution. This includes the persons who filed 230-23's, those who verbally expressed adverse health effects, and those who occupied the rooms but did not complain to the principal or to SEHU. After the SEHU designated mitigation efforts in rooms 1, 2, 3, and 4 were completed (i.e., rooms and unit ventilators cleaned, carpets removed, etc.) the affected persons were not contacted by SEHU to find out their perception of the solution. The children's parents were never contacted to determine the extent of their children's symptoms. No evidence could be identified showing that SEHU directly solicited information from affected and potentially affected individuals in their assessment of potential health impacts other than what was reported on the 230-23 forms.

While the AMA mold report has been available within MCPS since December 15, 1997, as of February 20, 1998 none of its information has been formally communicated to the staff and community. Yet, the report indicates the continued presence of mold in classrooms 1 and 3. As of this writing, MCPS has not made the community aware of the existence of this report.

In December 1997 and January 1998, two additional teachers located in other parts of the school filed indoor air quality complaints to SEHU, apparently due to severe allergic reaction to mold. However, as of early February, no one from MCPS had investigated these problems. As a result of these IAQ problems, the director of the YMCA center requested a transfer, and has now been re-assigned to another school.

Appendix C

BELMONT ELEMENTARY SCHOOL CASE STUDY -A COMMUNITY VIEW

Background

Belmont Elementary school is located in Olney, Maryland. It has averaged about 500 students over the past three years and currently has about 440 students. It was built in 1973 and was designed as an open space school. Over the years, MCPS has put up walls for classrooms, but there is no evidence that the ventilation system was reviewed or systematically adjusted to accommodate the new design.

As the roof aged, Belmont suffered from chronic leaks. However, even though the roof and the replacement of the carpet were planned events, the original carpeting was replaced during the summer of 1992, a full year ahead of the replacement of the roof which was replaced in the summer of 1993. This allowed the new carpet to become waterlogged in some areas so that it was a source of allergens and other potentially dangerous organisms. Poor housekeeping practices at the school also contributed to allergens and microbial growth within the existing carpet.

There is evidence to conclude that the building may not have been adequately maintained over a period of time. Filters were not changed as frequently as needed, carpeting and HVAC units were not sufficiently cleaned; repairs to ventilating equipment was not made in a timely fashion. It is not clear the extent to which the Building Service Staff had the proper training, supervision, equipment and supplies to maintain the building. The lack of a preventive maintenance program for the school also contributed to the generally poor condition of the facility.

In August, 1994, the installation of a poured synthetic rubber gym floor to replace the original poured floor set off a chain of events which identified the conditions that have contributed to additional air quality concerns at Belmont in Spring, 1997.

Details

A New Gym Floor, Noxious Odors, PTA Complaints, MCPS Actions and Reactions

In the spring of 1994 MCPS contracted for a synthetic, poured replacement floor for the Belmont gymnasium. The work was done the first two week in August of that year. At the time no one, except a few staff members who were working in the building during the last days of the summer, noticed the terrible odor permeating the school. They experienced some discomfort from the fumes, but thought little of it except that they would be glad when the floor dried and the odors went away. In fact, they experienced several symptoms including tightness of the chest, nausea, disorientation, and loss of appetite. Initially, the staff did not associate these symptoms with the floor, nor did they think them serious. No one, including the principal, ever considered that toxic and hazardous chemicals would be used in a public school.

The MCPS Safety and Environmental Health Unit did not review the documents relating to the chemicals to be used or the application process which was being proposed to create the floor prior to the contract being set. This was not an oversight on the part of SEHU; it was, and is, regular operating procedure for MCPS. The Division of Maintenance was the Division responsible for oversight of the project.

After school opened in September, many staff members and parents complained about the odors and the gym floor was the topic of heated debate at the first PTA meeting. The school principal contacted the Project Coordinator (an MCPS Maintenance employee who was responsible for overseeing the replacement of the gym floor) to voice the concerns of staff and community and was assured that there was no reason to be concerned. No one came out to inspect the building as a result of this conversation. Even though the bid contract for the installation of the floor required that the contractor establish that proper ventilation was available and maintained during the project, there is no evidence to suggest that the ventilation in the building was checked to be certain that it was functioning properly either before the floor was poured or after the initial complaint that the odor was permeating the building. Federal and State laws require this as part of the labeled instructions which must be followed.

The Belmont Building Services staff were not instructed on when and how to put the sealer on the gym floor. Because of this the sealer was applied when it arrived at the school a few days after the installation was completed. The sealer should have been used thirty days after the installation in order to give the chemicals sufficient time to cure. Instead, the sealer prevented the proper curing process from occurring and exacerbated the odor emanating from the floor.

In the fall as the odor did not dissipate, the PTA asked a parent with extensive knowledge and expertise on the subject of toxic chemicals to follow up on the continuing concerns. This parent requested copies of the chemical data sheets of the floor and asked if it had been used in any other MCPS school with the resulting release of vapors. He further asked if MCPS had tested the ambient air in the building, particularly in the gym. The response to these requests was that the air in the gym had not been tested and that MCPS had used the floor in several other schools and not experienced any problem. Because of the continuing concern, the principal, in cooperation with SEHU after a site visit was made, closed the gym to student use until the composition of the odors could be determined and deemed safe for children. As the year progressed, the community learned that this type of floor is comprised of a proprietary mixture of iscocyanates which can be hazardous to people's health and requires the contractor's employees to wear personal protective equipment while pouring the floor. In the spring of 1995, parents from Belmont visited the other schools that had this type of floor poured during the summer of 1994 and learned that in each of the other schools there had been a problem with noxious odors.

In November 1994, the principal sent home a letter to parents based on her discussions with MCPS Facilities Management staff. The letter indicated that the result of standard MCPS initial air quality testing (tests that were not suitable to detect chemicals emanating from the gym floor) at Belmont found it to be safe and, after extensive discussion with the contractor, that no toxic compounds were found. However,

since the odor was still noticeable, parents could opt to have students excused from activities in the gym if the odors bothered them.

At this point, the parent who had been investigating the problem spoke with a staff member from SEHU and learned that the tests which had been run were not suitable for detecting the presence of the chemicals which could have been created when the gym floor was poured. MCPS did not have the equipment which would identify the chemicals in question and so had simply used the equipment and tests it had. Maryland OSHA conducted tests within the gym in January 1995 and requested from the manufacturer and installer a listing of the chemicals used and created during the installation process. Meetings were held with the parent and Facilities Management staff to allay the concerns about the chemicals used on the gym floor.

Parental concern continued to be high and there was a great deal of anger and anxiety about the safety of students. At one point, staff from SEHU placed an ozone generator in the gym office which was promoted for use as an "air purifier." The next day the generator was removed by the vender without notice to the school. The ozone generator had been used after school hours with no employees or students in the area. It was used in this situation to see if the odors would dissipate. When the parent read the company literature on the purifier, he noted that its use could be dangerous when in areas of certain industrial chemicals. Since, there had been no communication to Belmont parents of why the purifier was being installed or removed, this information only fueled their concern about the quality of the air their children were breathing while at school. It was not until after this incident, some two months after they were requested, that SEHU was able to produce the chemical data sheets for the installed floor.

During the period of October 1994 through January 1995 the Belmont staff and parents met several times with the MCPS Director of Facilities Management, SEHU staff and representatives from the company which had installed the gym floor. At each meeting the school community was assured that MCPS was doing all it could to determine the source of the offending odors and that there was no reason for concern. However, MCPS never provided that assurance in writing nor had any action been taken to objectively verify these assertions. In January 1995 the school principal, on advice of the facilities management staff, sent a letter to parents stating that MCPS had found the gym free of toxic substances and could now be used. At this point, neither MOSH, MCPS, the manufacturer nor the installer had conducted the appropriate tests on the gym, yet the assurances had been given. The parents remained unconvinced.

Serious Ventilation Problems Found

In October 1994, a Belmont staff member filed a complaint with Maryland Occupational Safety and Health (MOSH). During the same time frame, SEHU communicated with MOSH Consultation and Compliance Services for air testing to be done. These tests were not performed until January 1995. MOSH standards are for adults in an industrial setting whereas the Maryland air quality laws which are for outside air are 100 times lower. By that time the odor was much less noticeable and the accompanying physical complaints had lessened. The results of the MOSH testing were inconclusive as to the chemical vapors; but MCPS was cited for not providing the chemical MSDS within twenty-four hours of a request, a violation of health and safety codes. By now the school community was

wondering why the ventilation system of the gym which, according to MCPS staff, was supposed to be independent of the main school building, had allowed vapors to enter the closed spaces of the classrooms and corridors of the school. They petitioned MCPS to test the ventilation system for the entire school and set up a PTA subcommittee to continue to investigate their concerns.

Many meetings were held with MCPS staff, assurances were made that there were no problems but it was not until May 1995 that MCPS conducted a maintenance inspection. This inspection found that the main ventilation system in the gym was operating at about 20 percent of the design capacity when the outside doors were open and at considerably less that 20 percent when the doors were closed. They also discovered that the main building was under negative air pressure relative to the gym so that air was venting through the gym into the rest of the building.

This investigation, done nine months after the gym floor had been replaced resulted in these findings:

- MCPS could not find the documentation that went with the ventilation system at Belmont;
- The AHU fan blades in the gym were dirty, broken or missing and thus not functional;
- No replacement filters for the system were in the school or available from the MCPS warehouse;
- Filters were dirty or missing on the main air handler in the gym;
- The return air duct for the gym ventilation system had never, in the school's 20 plus years, been connected; a cinderblock wall separated the return air vents from the return air duct to the air handling unit;
- The blower system was so worn out that it needed to be replaced; and
- An additional fan needed to be installed and operated continuously to ensure adequate overall ventilation.

These findings support a conclusion of inadequate maintenance of the ventilation system in the gym. Given the larger ventilation problems in the building, the Department of Facilities Management decided to take no action on the gym ventilation until the scope of the school wide problem could be determined. By June 1995, the Belmont PTA and staff were notified that much of the school's heating, ventilation and air conditioning (HVAC) systems were inoperative.

In June 1995, MCPS did make an effort to establish the nature of any remaining fugitive emissions associated with the isocynates chemistry used in the gym floor. These tests, which were expensive, indicated that at that time there were no remaining isocynate homologue emanations from the floor.

While this established that at this time the floor was no longer a safety concern, related

to the isocynate chemicals, the community was insistent that this did not establish the safety of the gym when it had been first brought to the attention of MCPS. In late 1995, Bayer Corporation tested virgin materials from Martin Surfacing. The test data were reported to MCPS in 1996. These qualitative "data" have not been explained and on the surface suggest that there is a possibility to toxic chemicals being released by the floor during installation.

Meetings between the Belmont community and MCPS continued through the 1995-96 school year. The parents lobbied to have tests run on virgin samples of the chemicals produced by the Bayer Corporation and the vendor, Martin Flooring. This was finally done late in 1996. Parent requests for an interpretation of the results have never been honored. SEHU has continued to request, by certified mail, the interpretation of the Bayer testing results; however, no such information as been received to date. As a result, of this controversy, the Director of Facilities Management stated that poured gym floors would not be used again in Montgomery County until testing results are received from Bayer Corporation. Parent requests to have this commitment put in writing have had no response and they continue to be concerned that these floors may be used again.

In September 1995, MCPS agreed to hire an outside engineering firm to assess the ventilation issues at Belmont. Many additional problems were discovered:

- The ventilation system throughout the building was operating at less than 20 percent of the original design;
- Mechanical units such as fans had frozen bearings;
- There were broken belts, blown fuses, and clogged filters;
- Some rooms had no functioning ventilation duct mechanism.

The same firm returned to Belmont in September 1996 to do a follow up assessment. They determined that many of the problems which had existed in 1995 were still not corrected. In addition, they noted that:

- Some rooms which had been created when walls were put up had no ventilation at all;
- Sewer pipes were located in front of unit air intakes on the roof; and
- Four of five main ventilation systems were still not functioning properly.

This report coupled with the inaction of MCPS resulted in a flurry of Maryland Public Information Act requests from the community. There were staff complaints about the air quality and a series of meetings were held with the new Associate Superintendent for Supportive Services. Early in 1997, this Associate Superintendent directed Facilities Management (SEHU) to have the indoor air quality at Belmont tested by an independent contractor. This was done in June of 1997; the results indicated that there were problems associated with airborne aerosols, fungi, dust mites and other allergens in the building. Remedial cleaning was attempted in July and August 1997. Follow up air quality testing demonstrated continuing problems and in late August, 1997 the decision was made to remove all of the carpeting in the building. (Approximately 95 percent of the building was carpeted at this time.)

What began as a concern about possible noxious chemical odors in the building resulted in the determination that the ventilation system was not functioning anywhere near the efficiency levels specified

in the original design and that the carpeting was harboring a variety of allergens which have a negative affect on some individuals. The carpeting at Belmont was completely removed during the fall semester of 1997. Belmont continues to be tested for microbes, temperature, humidity and ventilation efficiency (CO_2). None of this would have been determined if it were not for the perseverance of several highly knowledgeable parents who were determined to act in the best interests of their children.

Basic Problems Illustrated by this Case Study

The events at Belmont illustrate several problems with the current organization of SEHU as a unit within Facilities Management as well as pointing out inefficiencies within the structure of the Department of Facilities Management in general. These are summarized below:

1. The process used in deciding how to replace the gym floor at Belmont was inappropriate in the fact that the SEHU was not involved in evaluating the safety of the materials used, the adequacy of the ventilation system at the school, or time frame for completing the work.
2. The MCPS process for approving construction materials that was in place in the summer of 1994 did not require the SEHU review and approve use prior to the start of a project.
3. The initial response to concerns about the odor emanating from the new gym floor was lax. SEHU was not notified of the concerns of the school. Nothing was done to objectively assess the validity of the concerns.
4. Initial testing done on the gym floor was inappropriate given the concerns and chemicals involved.
5. Facilities Management staff was reluctant to admit that there might be a problem and seemed to dismiss the concerns of parents as irrelevant.
6. There was no adequate risk communication.
7. Serious ventilation problems that had existed over long periods of time were discovered. This further undermined the community's faith that MCPS was serious about correcting any problems.
8. School-based Building Services Staff were not adequately knowledgeable about the building in which they worked; were not adequately trained to identify problems; and did not have easy access to materials and equipment to keep the building operating at peak efficiency. Building Services staff does receive large group presentations on filters and cleaning methods.
9. MCPS Maintenance staff did not have the personnel or funds to adequately identify and address ventilation problems in the building.

Appendix D

SPECIFIC RECOMMENDATIONS REGARDING PROCESSING OF IAQ COMPLAINTS

Each of the following thirty-three detailed recommendations comes from the team's analysis of current MCPS IAQ complaint investigation practice. They also reflect a practical application of the organizing principles discussed in Section 3. For practical purposes, the nine page process flow diagram that reflects current practice is available from IAQ PAT records and is not attached to this report as an appendix.

Step 1 involves those actions taken at a school before and during the filing of a Form 230-23. This form is entitled **"INDOOR AIR QUALITY INQUIRY"**

D1.1 Change the title of the form from "air quality inquiry" to "air quality complaint" to signal to potential complainants that their complaints will be regarded

D1.2 The current form is six years old. Revise Form 230-23 to permit complainants to describe their symptomatic and environmental experiences more fully. They need to be guided through a series of questions/responses similar to those contained in the extensive IAQ complaint form documentation from the MidAtlantic Hygiene Resource Center that was provided to the SEHU Supervisor during IAQ PAT meetings.

D1.3 Tell parents they are permitted to fill out the new complaint form.

D1.4 Revise the -24 component of the Form 230-23, 24 to remove from building service managers the burden of making a medical or health judgment about the seriousness of an IAQ complaint. They are not qualified.

D1.5 Provide electronic version of this form either by letting parents and staff send in e-mail or by providing them a Web site at which they could formally submit a complaint.

D1.6 Provide BSMs and/or principals additional training or training materials to help them assist staff and other members of the school community who wish to submit the form.

This recommendation is intended to speed up the process by which the front end of the complaint process is handled. It is also intended to increase the accuracy of the information that the school and IAQ technical staffs receive from complainants.

D1.7 To assist complainants to understand the essentials of IAQ, schools and MCPS unions should maintain a small supply of the U.S. EPA document, "The Inside Story" at each

school. This document can be had at no cost from the IAQ Clearinghouse at 1-800-438-4318.

Step 2 involves those actions taken at a school after the filing of a Form 230-23.

D2.1 Forms submitted to school principals should be given to BSMs by the end of the next school day.

D2.2 BSMs should be trained to:

- Establish a schedule for examining all relevant mechanical equipment
- Tell complainant that investigation has begun
- Keep the principal informed
- Determine at the earliest possible stage whether this is a new or recurring problem by establishing whether the issue is addressed in the Building Maintenance Plan (BMP) adopted for the school (see Recommendation 5.4.1.)
- Contact complainant to check whether a presumed "solution" has, in fact, resolved the original complaint.
- Distinguish quickly whether the resolution of the problem is within their capabilities, whether they need to call in BSM supervisory assistance, or whether this is a problem for an IAQ professional investigator, lodged at a depot. (see Recommendation 5.5.2 and Appendix E for more information.)

D2.3 BSMs should NEVER close out a problem review without consulting the original complainant.

Step 3 involves actions taken by investigation unit if Form 230-24 is forwarded to it or if a telephone call is received asking for investigation

D3.1 Incoming problems need to have one of three priority levels assigned to each.

A. Emergency: stop all other activities and respond
B. Urgent: problem needs a rapid response but not necessarily instantly
C. Not urgent: problem whose response can be scheduled or can be handled on the telephone

The Process Action Team recognizes that some problems cannot be properly classified until a site visit or some other information is obtained.

D3.2 MCPS should establish a method for classifying incoming IAQ problems that emphasizes human health. If medical assistance is needed to do this, MCPS should retain that capability on an on-call basis. It should not rely on the county health department to conduct daily business.

MCPS should not downgrade the significance of a problem for resource or administrative reasons. Supervisors should waive ordinary administrative requirements and authorize overtime if a rapid response is needed.

D3.3 Field Equipment for Investigators

D3.3.1 Each investigator needs to have a complete equipment set, consisting of a digital hygrometer/thermometer, CO_2 sensor, wall moisture meter, velometer, smoke tubes, standard IH-level chemical tubes, and a micromanometer.

D3.3.2 The investigation unit needs to own a photoionization detector (for VOCs).

D3.3.3 The investigation unit needs to maintain a level-of-effort contract to obtain microbial sampling and VOC sampling services on a routine basis.

D3.3.4 MCPS should provide its investigation unit with a set of flow hoods appropriate to practical intake, supply, and exhaust openings in its buildings. We recommend that the Division of Construction share its flow hoods with the investigation unit.

D3.4 Site Visits

D3.4.1 Urgent visits should occur within 24 hours. Non-urgent visits should occur within 5 working days.

D3.4.2 The Division of Maintenance depot supervisor should be notified that a site visit is to occur. BSMs should be present at site visits. All recipients of the form should be informed in a timely manner.

D3.4.3 MCPS should adopt standard operating procedures (SOPs) for the performance of building visits.

The Process Action Team listened to considerable detail about how such visits are now conducted and was disturbed by the amount of imprecision and inconsistency in current activity. While the team recognizes that IAQ investigation requires considerable professional judgment, there should be no confusion about the interpretation of county code, ASHRAE guidelines, Board comfort zone settings, and state air requirements.

D3.4.4 The investigator should have the authority to require actions that clearly can be made on the spot, particularly in urgent circumstances.

Insofar as remediation cost is often a potential concern, MCPS should write specific guidelines for field investigators and maintenance depots that preauthorize that certain classes of problems do not need higher management review.

Step 4 concerns the development of corrective actions.

D4.1 The current system is flawed, as is explained in Appendix E. The following recommendations are based on the acceptance of the PAT's fundamental recommendation (also see Recommendation 5.5.2)

D4.1.1 MCPS should stop issuing corrective action memoranda through the Department of Facilities Management.

D4.1.2 MCPS should create a three-tiered system of corrective actions

Level 1 - field authorization through the investigator (see D3.4.4)

Level 2 - joint authorization through the field investigator and depot manager if mitigations exceed preauthorization levels. Appeals to this decision are to be taken to the oversight manager described in Appendix E.

Level 2 corrective actions may require the convening of a corrective action board, as described in Recommendation 5.5.4

Level 3 - authorization by the oversight manager described in Appendix E

Appeals from her/his action are to be taken to the MCPS Superintendent.

D4.2 MCPS should communicate its corrective actions decisions to the complainant, principals, interested individuals, organizations within the school community, and affected employees in a timely manner, or,

D4.3 If MCPS determines that a corrective action is not needed, it should document and communicate its reasons to the people listed in D4.2.

Step 5 concerns how MCPS evaluate the success of its IAQ corrective actions.

D5.1 MCPS should base success on the correction of the underlying problem that instigated implementation of the action.

This means that if a plan is put into effect, success is not to be measured by whether the plan's actions have been completed but by whether they solved the problem.

Appendix E

ESTABLISHMENT OF A NEW OFFICE OF ENVIRONMENTAL OVERSIGHT (OEO)

As the Indoor Air Quality Process Action team's final report indicates (Section 4.7 and 4.9) the system for indoor air quality problem response has proved inadequate. Therefore, we recommend a restructuring of the current response unit into a larger Office of Environmental Oversight. This office would be given greater authority to provide that response. The new office would be headed by a Director, who would report directly to the Associate Superintendent for Supportive Services. The Indoor Air Quality Process Action Team was not asked to consider the safety functions of the current Safety and Environmental Health Unit but recognizes these functions need to be placed in some organizational unit.

Therefore, we suggest that MCPS consider dividing the OEO into a safety unit and an environmental unit. The office would be headed by a Director. This oversight office would not be organized under another department or division involved with indoor air quality problems.

In this office, there would be an <u>independent</u> Environmental Oversight Officer for environmental health who would report to the Associate Superintendent for Supportive Services. and would have the appropriate professional education and be certified in at least one pertinent component of the indoor air quality field. This individual would have direct access to senior MCPS management.

Functions, Roles, and Responsibilities of Office of Environmental Oversight

<u>General</u>

The OEO would have the following four functions, relative to indoor air quality These are the same functions described in Recommendation 5.5.2:

1. Responsibility for conducting high quality technical investigations of the most serious IAQ problems.

2. Training the building service and Division of Maintenance workers who are both the first problem responders and who implement the BMPs.

3. Lead responsibility and authority for IAQ mitigation decisions.

4. Responsibility for communicating with the public about IAQ problems

The OEO would not have the responsibility for maintaining compliance with ventilation codes, or for repairing ventilation equipment. That responsibility would remain with the Divisions of Construction and Maintenance. Ordinary routine school-based implementation of Building Maintenance Plans would remain with School Plant Operations.

But, we are also mindful of our own emphasis on the integrated nature of IAQ problems. So, we suggest that MCPS create the matrixed problem response structure, shown in Figure E-1 and Table E-1. (This system was introduced in Appendix D.) In this system, IAQ complaints would continue to be generated at schools, and would continue to be investigated initially by Building Service Managers. However, if the Division of School Plant Operations' BSMs and BSM Supervisors can not solve the problem, they would be able to turn to the IAQ specialists co-located at the three Maintenance Depots, as shown in Figure E-1. (The reason for this co-location is to build a sense of common ownership between the OEO's technical specialists and the people who perform the more in-depth maintenance activities for the approximate 62 schools per depot).

Problem Investigating and Corrective Action Authority

OEO's IAQ specialists will have authority carrying out problem investigations and for making the Level 1 mitigation decisions described in Appendix D (Recommendation D4.1). The OEO specialist and the Maintenance Division depot manager would have joint authority to make Level 2 mitigation decisions. In such cases, the OEO would be able to convene, and chair, a corrective action board (as discussed in Section 4.8 and presented in our Recommendation 5.5.4). Authority to resolve disputes would fall to the Oversight Officer.

Level 3 mitigation decisions are the most cost-intensive. While the PAT's entire set of recommendations is intended to minimize the incidence of such problems, we. recognize some are inevitable. The head of the OEO cannot be expected to have final authority for such decisions. Yet, the PAT thinks that it is vital for the OEO to be part of the final decision making process. One form that this could take is shown in Figure E-1.

As shown in Table E-1, if an emergency situation were to arise, the field specialist would be given authority to take immediate temporary action, even if the final response would require a Level 2 or 3 decision.

Training

The new office would provide IAQ training for supervisors in the Divisions of Maintenance, Construction and School Plant Operations as well as principals, directors and supervisors at all levels.

Accountability and Communications

The Environmental Oversight Officer would be held accountable to the school community and general public in the following manner. The person in this position would be required to speak directly and openly to the media. When indoor air quality arise at a

school, this person would be personally responsible to answer to the community. This level of candor would require the Environmental Oversight Officer to have routine access to the Superintendent of Schools as well as to report regularly at public School Board meetings.

Oversight of Construction, Renovation, and Maintenance

Although this function is not listed above, it would be useful for OEO to be a standing member of the decision making-committee with regards to construction and selection of contractors for new schools and be part of the Commissioning Committee that accepts the completed buildings.

Figure E-1
Matrixed Problem Response:
Integration of Technical Specialists in Oversight Office Operating Divisions

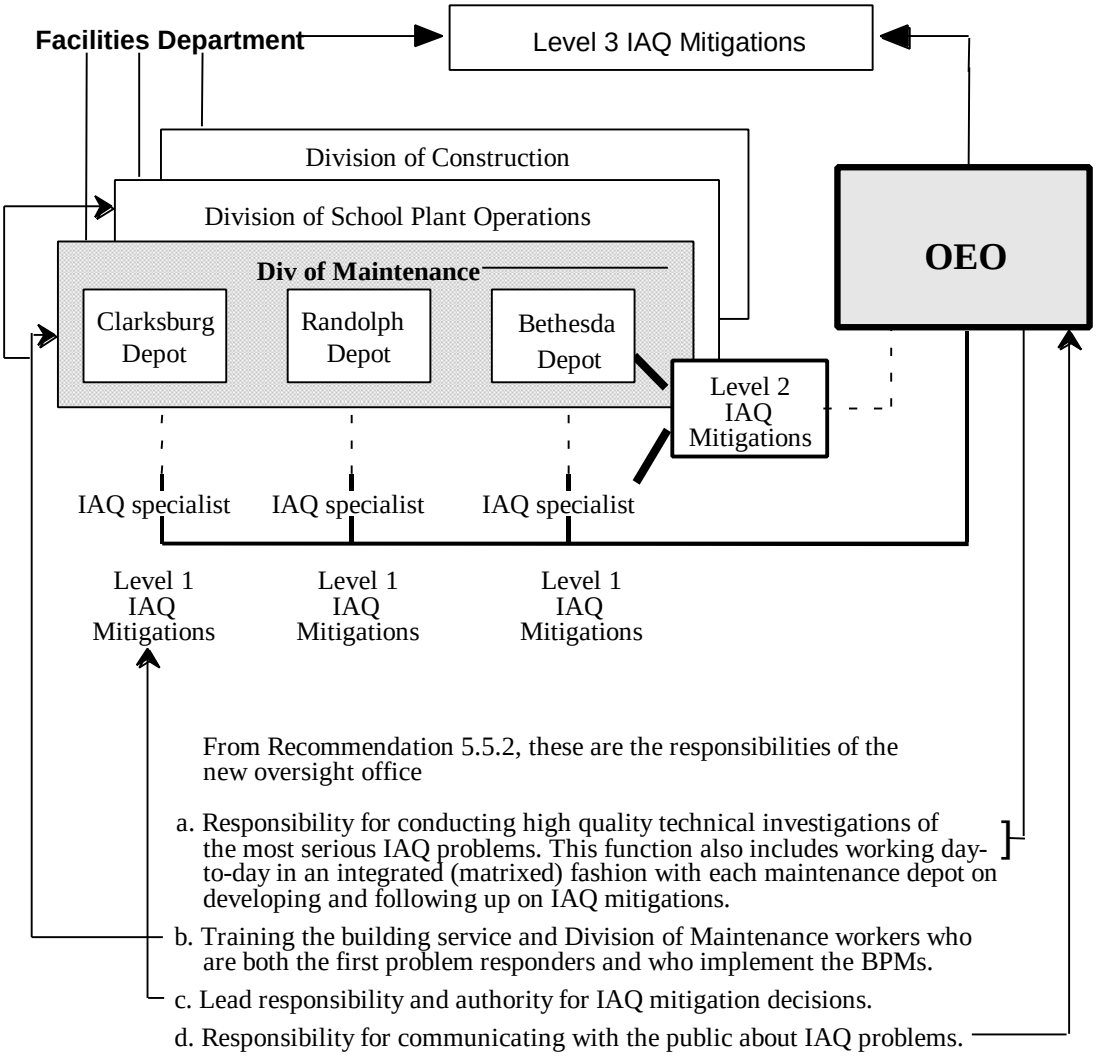

Table E-1
Recommended Authority of OEO Technical Staff
Relative to IAQ Mitigations

	Emergency	Urgent	Non-Urgent
Level 1: preauthorized mitigation type IAQ specialist	IAQ Specialist has authority to require immediate temporary action	IAQ Specialist has authority to require immediate temporary action	X
Level 2: mitigation not preauthorized IAQ specialist and Depot Manager		X	X
Level 3: Most costly OEO Officer and Facilities Manager		X	X