Establishment of an Indoor Air Quality Management Program at the San Mateo County Community College District

A thesis submitted to the faculty of
San Francisco State University
in partial fulfillment of the
requirements for the degree

Master of Business Administration

by

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San Carlos, California

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CERTIFICATION OF APPROVAL

I certify that I have read *Establishment of an Indoor Air Quality Management Program at the San Mateo County Community College District* by Linda Louise da Silva, and that in my opinion this work meets the criteria for approving a thesis submitted in partial fulfillment of the requirements for the Master of Business Administration degree at San Francisco State University.

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Establishment of an Indoor Air Quality Management Program
at the San Mateo County Community College District

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This research project explores the issue of indoor air quality (IAQ) at the San Mateo County Community College District. The research methods used consist of literature review of professional journals and articles on the subject, a historical analysis of air quality complaints and responses in the San Mateo County Community College District, and examination of the Environmental Protection Agency's data and recommendations on IAQ. The outcome of this project is an IAQ management program for the San Mateo County Community College District, comprised of a website component to educate visitors about IAQ in general and how concerns about IAQ are handled, a written training program for Facilities Department staff covering how they directly and indirectly affect IAQ and how to take action responsibly in the event of an IAQ concern, and a review and adjustment of maintenance protocols to ensure alignment with best indoor air quality practices.

I certify that the Abstract is a correct representation of the content of this thesis.

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Bruce Paton, Assistant Professor of Management Date

PREFACE AND ACKNOWLEDGEMENTS

As the administrator in charge of facilities maintenance and operations for the three colleges comprising the San Mateo County Community College District, I am responsible for providing information to the students, faculty, staff and visitors of Cañada College in Redwood City, College of San Mateo in San Mateo, and Skyline College in San Bruno about Indoor Air Quality (IAQ) in our facilities. I am also responsible for ensuring that my staff is fully knowledgeable of the issues surrounding IAQ, how their work may directly and indirectly affect the air quality in our facilities, and how to react responsibly when faced with a concern about IAQ. This study is the result of my interest and responsibility in this area of facilities management, and leads me toward my never ending goal of *Facilities Excellence.*

I am indebted to Dr. Christine Case, Professor of Biology at Skyline College, for her selfless dedication to the learning outcomes of her students and for inspiring me to focus this study on indoor air quality. Many thanks are due to my parents, Patricia and Bernardo Da Silva, who worked tirelessly to develop my ethical and educational foundation and whose pride and love continually fuel my efforts. Finally, I am grateful for my husband, William Mitchell, without whose moral support and understanding my work would not be possible – and for sustaining a loving environment that makes coming home such a pleasure.

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INTRODUCTION

Indoor air quality (IAQ) is a topic of much concern. According to the California Environmental Protection Agency (CEPA), the average American spends nearly 90% of his or her time indoors. Most of this indoor time is spent at home, although working adults spend approximately 25% of their time at an indoor location related to their employment, and children spend approximately 21% of their time at school on a school day.

The State of California has achieved outdoor air quality that is noticeably better than many other places in the world. Even so, the amount of air pollutants outside is much greater than that inside our buildings. Once emitted, however, indoor air pollutants are much less diluted, due to the partial trapping effect of the building shell. In 1988, K.R. Smith found that indoor pollutants are about 1000 times more likely to be inhaled than those same pollutants emitted outdoors (Smith, 1988).

Indoor air pollution can pose a significant health risk. If pollutant levels elevate high enough, building occupants can suffer adverse effects, the most significant of which include asthma attacks, cancer, heart and lung disease, and immediate irritant and neurological effects such as eye and throat irritation and headache, and premature death.

Sick building syndrome (SBS) is the name given to the nonspecific respiratory illnesses that have had recurring outbreaks in office workers since 1970. Symptoms include headache, fatigue, muscle aches, chills, and fever. With the growing media attention toward IAQ issues, many building occupants are fearful of sick building syndrome. The fear may or may not be founded in the physical presence of biological or

fungal microorganisms. In 1996, at the 1st Asian Indoor Air Quality Seminar, Dr. Alan Hedge from Cornell University presented a paper addressing the psychological impacts of IAQ (Hedge, 1996). Dr. Hedge's presentation indicates that the fear of IAQ problems and reports of SBS are generally not caused by exposure to poor IAQ, but rather to combined effects of various physical environmental and non-environmental factors. Most studies of IAQ complaints and SBS have found that there is good evidence that personal, psychological, and occupational variables affect individual sensitivities and susceptibilities to IAQ problems (Hedge, Erickson, and Rubin, 1992, 1995, 1996).

CEPA estimates that indoor pollution costs California's economy $35 billion each year. This estimate is derived from only partial costs of premature death and increased disease, increased expenditures for health care, decreased worker productivity, and decreased learning by school children. CEPA believes this number to be an underestimate, and that the total cost is likely much higher (California EPA, 2004). Perhaps more importantly, quality of life is diminished for those individuals who suffer adverse health effects attributable to poor IAQ – whether psychologically-driven or caused by actual physical conditions.

Despite the adverse health and economic costs of indoor pollution, no state or federal agency has explicit authority to regulate indoor sources of pollution. Indoor pollution remains the only major environmental health problem that does not have the benefit of a focused risk reduction program (California EPA, 2004).

Indoor air quality is an important issue to the San Mateo County Community College District (SMCCCD) because our students, faculty, staff and visitors deserve and

expect a safe, effective, and inspiring physical environment that supports and enhances the instructional mission of the Colleges. In the eight years of my employment with the District, I have responded to or known of twelve complaints of poor IAQ. When an individual perceives indoor quality to be substandard, they usually talk to their coworkers about it. As a result, although the average number of complaints of poor IAQ is relatively low, the number of people affected by any one complaint can be significant.

The costs of IAQ concerns – whether real or perceived – to SMCCCD have included lost employee productivity due to health effects, responding employee time, costs for industrial hygienists and laboratory analyses, workers' compensation claims, loss of credibility and trust in employer-employee relations, and opportunity costs of focusing attention on other priorities. These costs have not been – and cannot fully be – quantified. However – and particularly as economic constraints require public entities to find increasingly more effective and efficient ways to achieve their mission – it is imperative that we improve our ability to take appropriate action when faced with IAQ concerns. Moreover, it is my personal and professional responsibility to ensure a healthful learning and working environment. This research paper will analyze IAQ incidents at SMCCCD, examine industry-endorsed best practices for handling IAQ issues, and align best practices to the most pressing needs of the District to identify an indoor air quality management program for the San Mateo County Community College District.

METHODOLOGY AND DATA SOURCES

The research methods used consist of literature review of professional journals such as College Planning & Management and Maintenance Solutions, as well as academic literature on the subject. All information was publicly available. Secondly, this project included a historical analysis of air quality complaints and responses in the San Mateo County Community College District, including perceptions and opinions of faculty, staff, students and industrial hygienists, which were garnered contemporaneous to investigation and resolution of those IAQ complaints. A third area of research was examination of the Environmental Protection Agency's data and recommendations on IAQ.

RESULTS

A Review of IAQ Incidents Registered from December 1997 to October 2005 at San Mateo County Community College District

A review of the twelve IAQ incidents registered over the past eight years is important, as it reveals the types of concerns that have been received, the actions taken in response, and most importantly it serves to inform the behavioral modifications and proactive steps that are warranted to improve the IAQ management program at SMCCCD.

1. IAQ Incident No. 1

- **Location:** Cañada College, Building 3
- **Date complaint was received:** January 1998

- **Nature of the complaint:** A Cañada College staff member complained of an odor. Classified staff union representative submitted a formal complaint that the custodians were using a new toxic cleaning chemical, resulting in unhealthy working conditions.
- **Resolution:** The custodial supervisor confirmed that no new cleaning chemicals had been introduced, reviewed the inventory of existing chemicals and MSDS sheets, and verified that the cleaning chemicals were not causing the odor. Eventually a rotten orange was found in a faculty office drawer in the same building; it was removed and the odors dissipated. Complainants were satisfied with the resolution, although they were dissatisfied with the amount of time (approximately one week) that it took to achieve resolution.

2. IAQ Incident No. 2

- **Location:** College of San Mateo, Building 1
- **Date complaint was received:** March 1998
- **Nature of the complaint:** Staff members in the Student Services Department complained of poor air quality. Health effects complaints included respiratory illnesses.
- **Resolution:** Facilities Department responders ascertained that the heating/ventilating/air conditioning system was operating as designed, and that air quality was within normal parameters. An industrial hygienist performed air testing, the results of which indicated that the air quality was good. Interestingly,

air test results in offices often show concentrations of skin and cellulose cells that are higher than outside air; this is a result of the office workers spending many hours per day within their environment, together with the paper-based processes that they are performing. The air quality test results showed no evidence of poor air quality, but did show high levels of skin and cellulose cells as expected. The industrial hygienist noted that it was a time of year when many people experience upper respiratory illnesses (colds, flu), and that the Building 1 occupants were likely erroneously attributing their illnesses to SBS.

3. IAQ Incident No. 3

- **Location:** College of San Mateo, various locations
- **Date complaint was received:** April 1999
- **Nature of the complaint:** Faculty and staff complained to their supervisors about odors and exposure to roofing asphalt fumes at various locations at College of San Mateo. At the time, several buildings were being re-roofed at the center part of the campus.
- **Resolution:** Facilities Department responders worked with the roofing contractor and asphalt manufacturer to identify and use a low-fuming asphalt, in order to reduce the volume of asphalt fumes emitting from the asphalt kettle. The roofing asphalt MSDS sheet was provided to complainants, demonstrating that nuisance odors do not constitute a health risk. An open forum was conducted to share information about the roofing project scope, schedule, and associated campus

impacts; expert presenters at the open forum included an industrial hygienist, the roofing manufacturer's technical adviser, an OSHA representative, and Facilities Department personnel. College administration provided temporary alternate work locations for employees who were highly sensitive to asphalt odors. Complainants were satisfied with the resolution.

4. IAQ Incident No. 4

- **Location:** College of San Mateo, Building 9
- **Date complaint was received:** March 2000
- **Nature of the complaint:** A staff member complained of poor air quality related to mold growth in her work area on the first floor.
- **Resolution:** This was one of those typical "wicked" water infiltration problems in which it was very difficult to find exactly where the building envelope was breached and allowing water to infiltrate. The traditional methodology for handling a wicked water intrusion issue is to identify breaches and address them, and then water test again to ascertain if measures were successful. If additional sources of leaks are found, those areas are repaired, and then additional water testing is conducted to ascertain success. This can go on quite a few rounds, which can take months if not years. Meanwhile, the affected individuals may not understand why it is so hard to find and fix the leak(s); even if you explain the lengthy and redundant process of identifying and fixing leaks, they may not believe you – believing instead that their problem is being ignored or lowered in

priority. Meanwhile they will complain and discuss the perceived inaction or delays in action to coworkers, friends and their union representative. They may be concerned about the adverse health effects of exposure to the visible biological growth formations on wet ceiling tiles, walls and carpet. The perception of inaction and the escalation of bad feelings may lead to further adverse reactions (stress, feelings of distrust toward the individuals seeking to resolve the problem, possibly a psychosomatically-induced exacerbation of adverse health effects attributed to SBS, negative feelings toward the employer for not addressing the problem in a timely manner and for allowing unsafe working conditions).

In this case, a major source of rain water infiltration into the building was identified and repaired. Subsequent water testing indicated that additional smaller leaks were coming in through a roof deck that skirted the entire building at the second floor. A waterproofing consultant was hired to help identify the leaks and develop designs for a resolution. A 3-part epoxy and fiberglass based solution was applied to the surface of the roof deck. Interestingly, while the fiberglass fabric was being installed, new air quality complaints were lodged by building occupants. These complaints were related to exposure to fiberglass, with alleged adverse health effects including scratchy throats and coughs. The fiberglass cloth was being applied on the exterior of the building. The closest that building occupants came to the bare fiberglass fabric was probably 10', when it was being installed adjacent to the pathway between the building entrance and the campus quad. Small amounts of fiberglass cloth remnants (3" pieces) were blowing in the

wind, onto the walkway leading to the building entrance. The construction workers were directed to sweep up the remnant pieces of fiberglass cloth routinely, and the complainants were provided information from the material safety data sheets demonstrating that their exposure to the fiberglass remnants was not going to cause them adverse (or any) health effects.

Following application of the waterproofing material on the roof deck, minor amounts of rain water were still found to be entering through the window walls. The waterproofing consultant recommended replacement of the aged gaskets at the windows. A contractor was hired to remove and replace the aged window gaskets.

This multiple step resolution transpired over approximately three years and cost over $70,000 in consultant, contractor and responding employee time. The initial complainant has since taken another position, at a different location within the District. Other building occupants were satisfied with this resolution.

5. IAQ Incident No. 5

- **Location:** Skyline College, Building 1
- **Date complaint was received:** February 2001
- **Nature of the complaint:** Staff members in the Student Services Department complained of a stuffy environment, and of black particulate matter falling out of air supply registers.

- **Resolution:** Facilities Department responders discovered that previous Facilities Department responders had closed the dampers in a number of air supply registers, in order to prevent deteriorating duct lining material from blowing onto work surfaces. As a result, the appropriate number of fresh air exchanges was not occurring, resulting in stuffiness (inadequate oxygen, high levels of carbon dioxide). Air supply register dampers were opened completely to allow adequate air flows, and filter media were inserted into supply registers above work surfaces to capture deteriorated duct liner particulates. Complainants were satisfied with the resolution.

6. IAQ Incident No. 6

- **Location:** District Headquarters Office Building
- **Date complaint was received:** April 2004
- **Nature of the complaint:** Administrative assistant complained of black particulate matter falling out of the air vents and onto her work surface.
- **Resolution:** Facilities Department responders indicated that the particulate matter was deteriorating air duct lining – inert, nonorganic material that was not harmful. Complainant was not satisfied with this response. Skyline College biology students conducted air quality testing in the building and confirmed that indoor air quality was good. A separate lab analysis of the particulate matter confirmed that the material was inert and not harmful. Complainant was not fully satisfied with this response, and has subsequently retired. As a result of the

workstation being reconfigured as part of a renovation, the work surface is no longer directly beneath the air supply register. No complaints have been received from the current workstation occupant.

7. **IAQ Incident No. 7**

- **Location:** College of San Mateo, Building 18
- **Date complaint was received:** October 2004
- **Nature of the complaint:** Faculty union representative at College of San Mateo complained on behalf of faculty members that hot asphalt fumes from nearby roofing project were resulting in unhealthy working conditions.
- **Resolution:** A response was provided to the faculty representative that the hot asphalt kettle had been placed away from and downwind of occupied areas of the campus, as a means to mitigate nuisance odors that might enter classrooms and offices. A copy of the roofing asphalt material safety data sheet was provided to the faculty representative, detailing that minor nuisance odors do not exceed permissible exposure limits established by OSHA. The faculty representative was reminded that a notice was issued to the College community of the impending roofing project, and individuals were encouraged to keep windows and doors closed as a means of keeping nuisance odors out of the adjacent buildings. Complainant was satisfied with this resolution.

8. **IAQ Incident No. 8**

- **Location:** College of San Mateo, Building 15

- **Date complaint was received:** May 2005
- **Nature of the complaint:** Faculty union representative at College of San Mateo complained on behalf of faculty members that electricians installing fire alarm devices were disturbing asbestos containing building materials, causing unhealthy working conditions in a faculty office building.
- **Resolution:** A response was provided to the faculty representative that the asbestos containing building materials had been spot-abated prior to the electricians working in those areas where fire alarm devices were to be installed. A copy of the industrial hygienist's report subsequent to asbestos abatement was provided, which confirmed that the areas of fire alarm work were asbestos-free. Complainant was satisfied with this resolution.

9. IAQ Incident No. 9

- **Location:** District Headquarters Office Building
- **Date complaint was received:** May 2005
- **Nature of the complaint:** Payroll supervisor complained of sickening odor at her workstation.
- **Resolution:** A rotten orange was found in an adjacent workstation; it was removed and the odors dissipated. Complainant was satisfied with this resolution.

10. IAQ Incident No. 10

- **Location:** Skyline College, Pacific Heights campus, wings B and C
- **Date complaint was received:** August 2005

- **Nature of the complaint:** Skyline College Cosmetology Program faculty and students complained of mold and poor air circulation. Health effects complaints included eye, nose and throat irritation.
- **Resolution:** An industrial hygienist was engaged to take surface and air samples. Air samples verified that indoor air was good; surface samples found some localized areas of mold. The sources of moisture were repaired, and the areas of mold were removed and repaired. An open forum was conducted to share this information with building occupants. A number of the complainants were not satisfied with this resolution.

11. IAQ Incident No. 11

- **Location:** College of San Mateo, Building 16
- **Date complaint was received:** September 2005
- **Nature of the complaint:** Faculty union representative complained on behalf of members that the new resilient floor tiles installed in the building were offgassing, resulting in unhealthy working conditions.
- **Resolution:** The resilient flooring product installed in Building 16 is chlorine free and contains no plasticizers. It is virtually VOC free. It has a slip resistance coefficient compliant with OSHA recommendations, extremely low smoke emissions (when ignited) compared to other flooring options, and the manufacturer of the product has received ISO 14001 Environmental Management System recognition for its clean manufacturing processes. The resilient floor

product does not require dressing and cleaning with caustic chemicals, minimizing its lifetime cost and environmental impact. An analysis of the chemical and physical properties of the floor material was provided to the faculty representative. The complainant was satisfied with the resolution.

12. IAQ Incident No. 12

- **Location:** Cañada College, Building 18
- **Date complaint was received:** October 2005
- **Nature of the complaint:** Cañada College chemistry laboratory aide complained of odors and stuffiness in chemical stockroom. Health effects complaints included sinus and throat irritation.
- **Resolution:** Facilities Department responders noted that the exhaust system in this room is operating, and that the supply and exhaust air systems in adjacent rooms are also operating as designed. In fact, the supply and exhaust air systems in the chemical stockroom were designed and constructed so that more air is exhausted than supplied – resulting in negative air pressure that ensures that odors associated with the chemicals being stored are removed from the room continuously (24 hours per day, 7 days per week). The exhaust fan is very noisy, however, and a switch to activate or deactivate the exhaust fan is accessible to the lab aide. In addition, the introduction of organic chemistry to the curriculum has resulted in the addition of different chemicals that may emit a stronger odor than what the lab aide has previously experienced. The noise nuisance issue and the ability of the stock room aid to deactivate the code-required exhaust system will

be addressed when the building is renovated (scheduled for 2006). Meanwhile, the lab aide and her supervisor have been advised not to deactivate the exhaust system.

Factors Affecting IAQ

Brooks and Davis (1992) summarize three factors that appear to be common to most indoor air quality problems: the presence of point sources of pollution, the presence of a susceptible population, and inadequate ventilation. They theorize that by studying and addressing all three factors of satisfactory climate conditions, healthful indoor air quality can be created in any building. The CEPA provides five distinct methods to prevent and reduce indoor air pollution (CEPA, 2004):

1. Reduction at the source is most effectively achieved through use of low or zero-emitting appliances, products or materials, or reformulation of chemical products. Low emission product designs or reformulations can usually be accomplished by the manufacturer, with minimal impact on the consumer, often with only minor cost increases.
2. Ventilation is a standard engineering approach to assuring good indoor air quality and comfort. Ventilation not only removes and dilutes indoor contaminants, it also removes moisture from the air which helps to prevent mold growth, and removes body effluents such as carbon dioxide that lead to a stuffy environment. However, ventilation is not a complete solution to indoor pollution. Ventilation

consumes energy, and some pollutants, such as formaldehyde emitted from building materials, require years to offgas and are not completely removed by ventilation. Finally, the benefits of ventilation are reduced when outdoor air pollution is present, because indoor pollutants will just be replaced with outdoor pollutants.

3. Public education is a key step for reducing exposures to many indoor air pollutants. People's choices and activities have a major impact on their exposures to air pollution. The use of various consumer products, cigarette smoking, cooking, and other activities can result in significant indoor releases of pollutants.
4. Air cleaning devices can also help improve indoor air quality; however, their effectiveness is often very limited. Air cleaning devices include both central air filters and portable air cleaning appliances. Air filters are a normal component of mechanical HVAC systems in public and commercial buildings; high efficiency particulate arrestor (HEPA) filters are most effective at removing particles from outdoor air as it is brought indoors. Air cleaning appliances are usually portable units used indoors to remove particles from the indoor air, although a few remove gases, and some do both. Mechanical air cleaners typically draw air through a filter while electronic air cleaners remove pollutants with the use of an electric charge.

Electrostatic precipitators (ESPs) and ionizers are the two major types of electronic air cleaners on the market. The proper size and type of air cleaner may

help control airborne particles for people with special sensitivities, such as those with asthma or allergies, who use them in confined spaces such as in their bedrooms. However, the limited scientific evidence available has not documented any health benefits from air cleaners. Air cleaning appliances are generally not effective at removing gaseous pollutants, and typically are not designed to do so. Additionally, ESPs and ionizers can produce ozone as a by-product; thus proper use and maintenance is critical to prevent harmful levels from developing when using these devices. Air cleaners that intentionally generate ozone should not be used indoors (DHS, 1998; ALA,1997). Independent studies by the U.S. EPA, the Consumers Union, and others have shown that ozone-generating air cleaners do not effectively destroy microbes, remove odor sources, or reduce indoor pollutants enough to provide any health benefits. These devices can emit substantial amounts of ozone, an irritant, but they are currently unregulated.

5. Finally, proper operation and maintenance of buildings is critical to achieving and maintaining healthful air quality in buildings. Ventilation systems should be maintained as intended and filters replaced routinely to prevent soiling and the growth of mold and bacteria in the ventilation system and in the occupied space. Roof leaks that are not repaired promptly can lead to moisture intrusion and mold growth. Such factors not only lead to poor indoor air quality, but can also prove more costly in the long term due to increased costs to remedy the larger problems that result.

IAQ Factor Analysis of SMCCCD's Historical IAQ Incidents

It is probable that an improved IAQ management program that incorporates CEPA's five elements would result in a reduction of the Brooks and Davis factors, as shown in Table 1 below. By reducing the presence of point sources of pollution, the presence of a susceptible population, and inadequate ventilation, each of our twelve IAQ incidents might not have occurred, or their impact might have been reduced.

Table 1: Application of CEPA Elements to IAQ Incidents at SMCCCD

Incident No.	Incident	CEPA Element(s)	Remarks
1	Odor from a rotten orange	3 – public education 5 – building maintenance	
2	Perception of unhealthy working conditions resulting from suspicions of poor IAQ	3 – public education	
3	Perception of unhealthy working conditions resulting from construction activity (release of hot asphalt fumes)	1 – source reduction 3 – public education	
4	Perception of unhealthy working conditions resulting from visible mold growth and suspicions of poor IAQ	3 – public education 5 – building maintenance	
5	Perception of unhealthy working conditions resulting from suspicions of poor IAQ (black particulate fallout from air supply system)	3 – public education 5 – building maintenance	
6	Perception of unhealthy working conditions resulting from suspicions of poor IAQ (black particulate fallout from air supply system)	3 – public education 5 – building maintenance	
7	Perception of unhealthy working conditions resulting from construction activity (release of hot asphalt fumes)	3 – public education	CEPA element 1 – source reduction – was already in practice
8	Perception of unhealthy working conditions resulting from construction activity (electrical work on walls known or suspected to contain asbestos material)	3 – public education	CEPA element 1 – source reduction – was already in practice
9	Odor from a rotten orange	3 – public education 5 – building maintenance	
10	Presence of mold, perceptions of poor IAQ and dangerous learning environment	2 - ventilation 5 – building maintenance	
11	Perception of unhealthy working conditions resulting from construction program (offgassing of new floor tile)	3 – public education	CEPA element 1 – source reduction – was already in practice
12	Stuffiness and odors in chemical stock room	2 - ventilation 3 – public education 5 – building maintenance	

The Need for a SMCCCD IAQ Management Program

Given that the three campuses of SMCCCD are comprised of 70 buildings totaling over 1.25 million square feet of indoor space, and that 40,000 students and 1,000 employees use the facilities annually, twelve registered complaints of IAQ over eight years is not a bad statistic – particularly since we did not find poor IAQ conditions in any of those incidents.

Nevertheless, Iwashita said it best in a 1992 unpublished thesis:

> *"The human being is the ultimate judge of indoor air quality,*
> *and the traditional hygienic/chemical method at this stage*
> *can be regarded as insufficient to define*
> *the quality of air as perceived by human beings."*
> *(Iwashita, 1992, p.23)*

Iwashita's wise words caution that perception is reality. The health effects of the individuals involved in those twelve incidents – whether physiologically or psychosomatically induced – diminished the quality of their lives. The response efforts included direct costs of employee time, consultant costs and laboratory analyses; more importantly, there was a reduction of trust between complainers and responders and in the perceived safety of our campus facilities.

With the onset of a ten year major facilities capital improvement program in 2002, involving major and minor renovations of existing facilities as well as new construction, the frequency of IAQ concerns has increased. Four out of seven of the IAQ concerns registered since 2002 have been related to the capital construction program (incidents number 7, 8, 10 and 11). Implementation of a complex construction program on fully operational college campuses is challenging: students, faculty and staff are subject to

noise, dirt, pedestrian and vehicular traffic impacts, utility shutdowns, and general disruption. In addition, they will continue to experience roofing projects with associated asphalt fumes, the introduction of new and different building materials (such as carpets, resilient flooring, paints, furniture) that may be unfamiliar, as well as hazardous materials abatement work, dirt movement activities, and demolition activities that will cause concern about air quality. Clearly a proactive IAQ management program must be developed, in order to ensure a healthful learning and working environment and in anticipation of the increasing trend of IAQ concerns resulting from construction disruptions and ever-increasing media exposure.

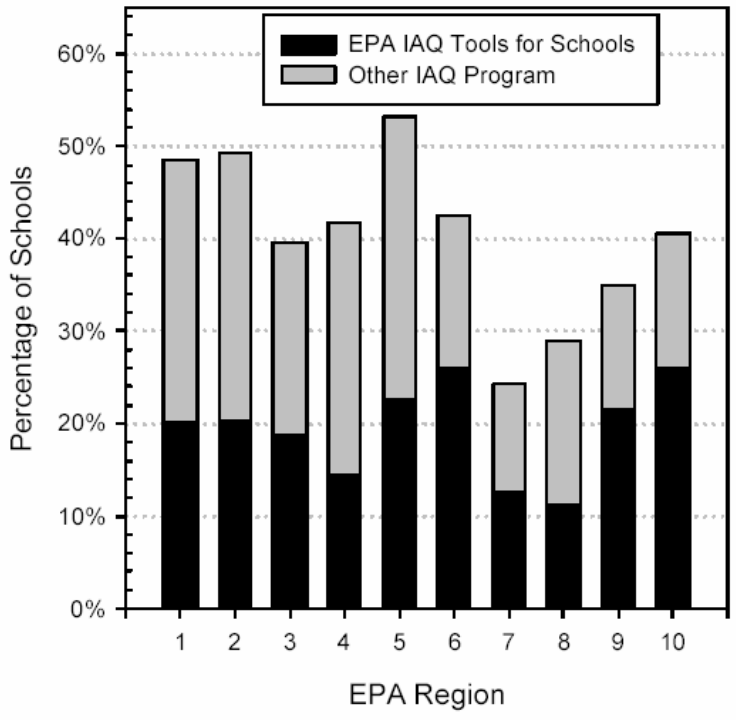

Figure 1 Percentage of Schools with an IAQ management program by EPA Region

Figure 1, above, shows that fewer than 35% of schools in EPA's Region 9, which includes California, have IAQ management plans (Moglia et al, 2005). While SMCCCD is not alone in not having a proactive IAQ management plan, it should not take solace in this fact. Figure 2, below, shows that schools with an IAQ management program have significantly higher rates of best practices that achieve healthy IAQ than schools without an IAQ management program (Moglia et al, 2005). If SMCCCD is to provide a safe, effective, and inspiring physical environment that supports and enhances the instructional mission of the Colleges, then clearly we must develop an IAQ Management Program.

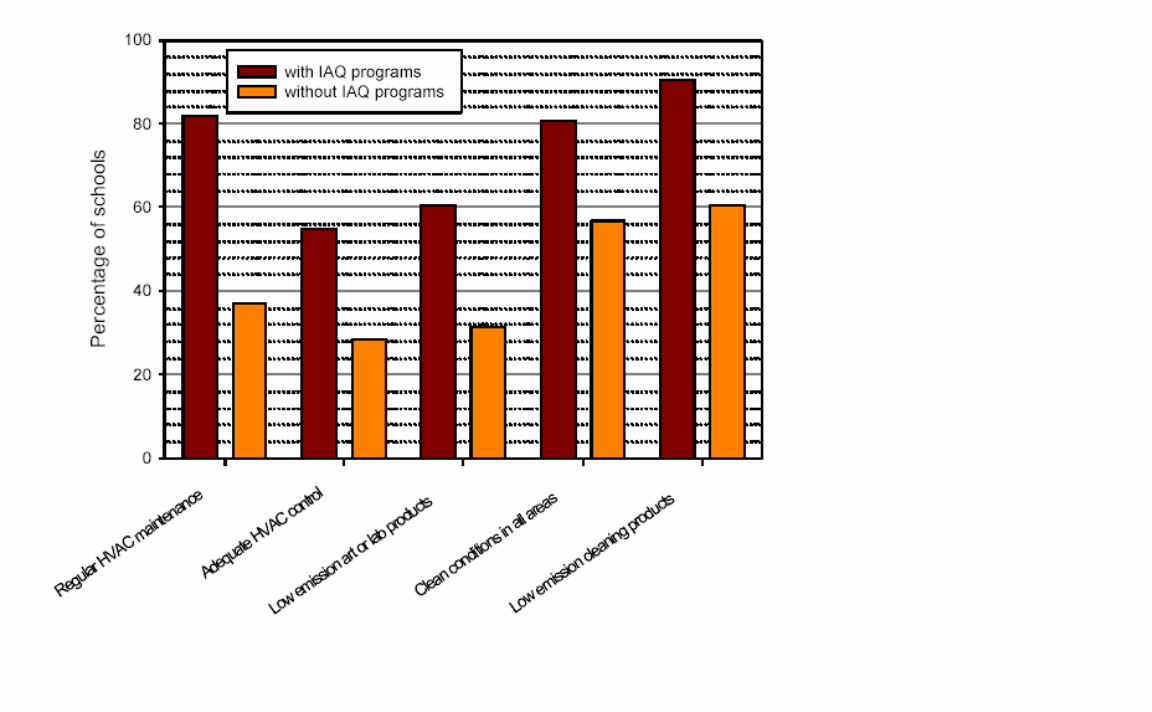

Figure 2 Comparison of IAQ management practices between schools with an IAQ program and those without.

IAQ Management Program Models

In 1995, the U.S. Environmental Protection Agency (EPA) launched the "IAQ Tools for Schools" Program (IAQ TfS). The IAQ TfS Program is a comprehensive program that provides an IAQ TfS Kit, publications, resource references, an awards program, annual symposiums, and design guidelines. The TfS Kit constitutes a self-contained IAQ Management Plan, comprised of a set of flexible and specific activities for preventing and resolving IAQ problems. The goals of the IAQ Management Plan as outlined in the IAQ TfS Kit are to 1) fix any existing IAQ problems; 2) instill an IAQ awareness that leads to preventive actions; and 3) resolve IAQ complaints and incidents as they occur. The kit is available at no cost to schools across the U.S. The premise of the kit and the program is that many IAQ problems in schools can be solved in-house, at low or no-cost, by using the EPA guidance. The kit contains a set of activities designed to produce an evaluation of the health of the school building, a framework for achieving and maintaining good IAQ, and for solving IAQ problems. The kit relies on a team approach with strong emphasis on educating and communicating and interacting with building occupants (EPA, 1995). The kit has a roadmap of seven steps to activate the IAQ management plan:

Table 2: EPA IAQ Tools for Schools IAQ Management Plan

Step	Action
1	Identify key members of the indoor air quality team to work with the IAQ coordinator. These may include teachers, administrative staff, facility operators, building maintenance staff, local health department officials, contract service providers, and parent representatives.
2	Distribute action packets to the team members. The action packets provide specific information on indoor air quality relevant to the team members' functions, and allow an audit of the school building to determine potential sources of indoor air quality problems. Team members submit completed checklists to the IAQ coordinator indicating their findings.
3	Review the checklists, conduct a walkthrough inspection, and identify priorities for building repair, upgrade, and improved maintenance.

4	Get consensus and approvals for repairs, upgrades, and improved maintenance activities and perform these activities as approved.
5	Conduct follow-up inspections to determine if repairs, upgrades and improved maintenance have been properly completed and have achieved the desired results.
6	Develop and follow a schedule for upcoming activities, such as remodeling, staff changes, and completion of checklists and monitoring activities that affect indoor air quality.
7	Maintain good documentation and files for all completed forms, records of repairs or maintenance changes, memos, final reports, and activity reports. Key staff should be made aware of their responsibilities to maintain documentation.

The IAQ TfS voluntary IAQ management plan was developed by the EPA as a means for schools to obtain the information required to responsibly manage IAQ. Thousands of these kits were distributed to schools across the United States, and initial public interest in using the kits was high. Several years later, however, it became clear that few schools were actually using the kit. Many barriers were identified, as state and federal program offices tried to understand the reluctance to use the program. Many of these barriers were a matter of perception. They included a presumed prohibitive time investment by already overburdened school staff, fear of creating more problems than might be solved by calling attention to IAQ issues, and fear that the activities and guidance might uncover major, costly repairs not previously identified. For schools struggling with an IAQ issue, there was sometimes a mentality that ignoring an IAQ problem would make it disappear. Yet, after years of experience, all of these fears have proven unwarranted and the kit has been used successfully in many areas of the country (Moglia et al, 2005).

A study of the adoption of the EPA "IAQ Tools for Schools Kit" in the New Jersey school districts revealed that schools did not readily adopt the free kit and program. In late 1998, EPA Region 2 and RK Environmental and Occupational Analysis,

Inc. devised a solution to the challenges of getting schools in New Jersey to participate in the IAQ Tools for Schools program: they provided intensive training, technical support, and hand-holding to those who were willing to commit to try the program for one year. This initiative, known as the "NJ IAQ Tools for Schools Network", offered three training workshops spread over the course of the school year. Schools that enrolled had to make a commitment to stay in the Network for the year and to perform the basic activities outlined in the kit, particularly the IAQ checklists and building walkthrough, and to report back for a final debriefing session (Feola et al 2002). The three training workshops offered by the Network are outlined in Table 3.

Table 3: NJ IAQ Tools for Schools Network Training Workshops

Session 1	
1	Creating Buy-In for an IAQ Management Program
2	Introduction to IAQ Basics
3	Unique Aspects of the School Environment
4	The 4-P's of Good IAQ
5	The New Jersey State IAQ Standard
6	Detailed Introduction to the IAQ Tools for Schools kit
7	Forming an IAQ Team
8	Conducting a Baseline Assessment Using the IAQ Checklists
Assignment:	Designate an IAQ coordinator, Form an IAQ Team, Distribute and Collect IAQ Checklists
Session 2	
9	Review of IAQ Basics
10	Review of IAQ Checklist Findings
11	Basic IAQ Measurement (Hands-on Learning Activity)
12	Prioritizing Checklist Findings
13	How to Conduct an IAQ Walkthrough
Assignment	Compile and Prioritize Checklist Findings, Map out Checklist Findings on Schools Floor Plan, Conduct an IAQ Walkthrough investigation (with or without taking IAQ measurements)
Session 3	
14	Review of IAQ Walkthrough Findings
15	How to Prioritize Findings and Develop a Maintenance/Repair Schedule
16	Other Indoor Environmental Issues of Concern to Schools

17	Green Cleaning/Cleaning for Health
A	Open Airways for Asthma
B	Integrated Pest Management
C	Lead and Asbestos
D	Radon
E	Mold
F	Energy Efficiency/Sustainable Buildings
G	Mercury in Schools

An IAQ Management Program Model for SMCCCD

The IAQ program models reviewed assume that a school has resources (employees and available funding) to perform inspections, complete checklists, identify priorities, achieve consensus on the prioritized plan, execute the repairs, and conduct follow-up inspections to confirm the repairs have been performed. At SMCCCD, as with most public educational institutions, those "spare" resources are a luxury! Facilities Department program reviews have shown that custodial, grounds and maintenance staffing is at 50% of the lowest benchmark level for other institutions of higher education (level 5 – unkempt neglect). It is difficult to imagine what half an amount of unkempt neglect is, but that is apparently the level at which the Facilities Department is staffed. With this level of staffing, SMCCCD is not going to assign an IAQ coordinator and activate an IAQ team proactively.

A reasonable IAQ management program for SMCCCD will acknowledge the severe staffing constraint. An appropriate IAQ management program will also focus limited resources where they will have maximum impact: on CEPA elements 3 and 5

(public education and building maintenance). Given these parameters, SMCCCD's IAQ Management Program should be comprised of:

1. A web site to educate visitors about IAQ in general and how concerns about IAQ are handled.
2. A training program for Facilities Department staff, covering how they directly and indirectly affect IAQ and how to take action responsibly in the event of an IAQ concern. Focused training should be provided to the following classifications of Facilities Department personnel:
    a. Campus Facilities Managers, Custodial Supervisors and Staff Assistants
    b. Maintenance Engineers
    c. Groundskeepers
    d. Custodians
    e. Construction Planners and Project Managers
3. A review and adjustment of maintenance practices to ensure alignment with best indoor air quality practices.

Outcome: A Written IAQ Program for SMCCCD

SMCCCD's Facilities web site has a Frequently Asked Questions (FAQs) page. As a result of this research paper, I have developed an IAQ FAQ entitled "FAQs about Indoor Environmental Quality", and it has been posted at http://www.smccd.net/accounts/facilities/FAQs.htm. The IAQ FAQ is included in this research paper as Appendix 1.

The Facilities Department conducts technical training sessions for its employees on a monthly basis. I have developed a PowerPoint training presentation on how employees directly and indirectly affect IAQ and how to take action responsibly in the event of an IAQ concern. This training module will be added to the rotating technical training schedule effective June 2006. The PowerPoint training presentation for Facilities Department personnel is included in this research paper as Appendix 2.

Preventive and reactive maintenance activities at SMCCCD are tracked using a web-based computerized maintenance management system. I have reviewed and modified the preventive maintenance checklists for equipment and systems that affect IAQ; the improved versions that incorporate best air quality management practices have been included in this research paper as Appendix 3.

Despite best efforts at proactively preventing IAQ issues, it is inevitable that the Facilities Department will continue to receive IAQ concerns and complaints. I have developed a comprehensive IAQ Complaint Response Checklist, based on the IAQ TfS problem solving checklists. When a customer complains of IAQ concerns, the Facilities Manager will assign a responder to use the IAQ Complaint Response Checklist, which has been included as Appendix 4 of this research paper.

This multi-faceted IAQ management program is expected to address the majority of IAQ issues that may arise in the coming years. This written program provides the tools – both proactive and reactive – that will allow SMCCCD Facilities Department employees to understand their role in healthy indoor air quality, as well as improve their ability to take appropriate action when faced with IAQ concerns.

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FAQs about **Indoor Environmental Quality**

What is Indoor Environmental Quality?

Indoor Environmental Quality is the result of a conscious, collective effort to create and maintain safe, effective, and inspiring physical environments that support and enhance the instructional mission of the three colleges of the San Mateo County Community College District. This FAQ provides information regarding the use of chemicals in custodial services, the pride we take in ensuring superior indoor air quality, and facts about the effects of some typical interior architectural elements on indoor environmental quality, including resilient floors, carpets, paints, acoustic ceiling tiles, window treatments, and furniture. Together with the excellence in technology that Information Technology Services ensures, SMCCCD's indoor environmental quality inspires and promotes instructional excellence.

How does the Facilities Department Proactively Assure Indoor Air Quality?

The Facilities Department's staff of stationary engineers performs routine preventive maintenance tasks on heating/ventilation/air conditioning (HVAC) equipment; those tasks include daily systems verification screening to ensure equipment is operating within design parameters during building occupancy, replacing air filters that filter outside air contaminants before the air is circulated within our buildings, and ensuring that the equipment's mechanical components are lubricated, calibrated, clean and operating smoothly, and that the equipment's safety controls are functioning correctly. To learn more about the work of our maintenance engineers, please refer to Engineering Program.

Of course, our custodial staff uses professional means and methods to ensure that the indoor learning and working environment is kept clean. To find out more about custodial tasks and frequencies, please refer to Facilities Service Levels.

The capital construction program currently underway has prompted us to develop facilities design standards for HVAC equipment, paints, flooring materials, lighting and furniture based on a number of criteria, including

indoor air quality. To find out more about this, read the FAQs below for each of these elements.

Finally, although certainly not least in importance, SMCCCD's smoke free policy (no smoking within buildings or within 20 feet of windows, doors and air intakes) has had a positive impact on the quality of indoor air. This smoke free policy is applied to vehicles operated by the Facilities Department as well.

How does the Facilities Department Reactively Assure Indoor Air Quality?

The Facilities Department's staff takes great pride in ensuring healthy indoor air quality. Over the past decade, approximately one dozen complaints related to indoor air quality have been submitted from faculty and staff. Complaint categories include: unpleasant odors, roofing asphalt smells, visual signs of moisture leaks or dirt, allergy aggravation, upper respiratory symptoms and construction dust. In each instance, due diligence was followed to investigate the issue and achieve resolution. In every instance, follow up air testing showed that indoor air contaminants were well below established exposure limits. In most of the incidents, an educational effort served to allay fears of an unhealthy learning and working environment.

In 2006, the Facilities Department adopted portions of the Environmental Protection Agency's *Tools for Schools Indoor Air Quality Program* to ensure a timely and systematic response to indoor air quality complaints.

Of course we have also received numerous complaints of uncomfortable temperatures over the past decade. From 2002 to 2005, a web-based, state of the art digital environmental control system was installed that provides superior management of HVAC equipment (plus some non-HVAC equipment such as lighting, sewage pumps, vault condition sensors, etc.). At Cañada and Skyline Colleges, individual zone controls have been digitized as well. As a result of the improved controls system, the incidence of temperature-related complaints at our colleges has diminished dramatically. For more information about the digital zone thermostats and how to use them, please refer to FAQs About Temperature.

What can I do to Assure Indoor Air Quality?

As mentioned earlier, indoor environmental quality is a collective effort. These are the things you can do to ensure healthful indoor air quality:

- Please comply with the smoke free policy: do not smoke inside buildings, nor within 20 feet of operable windows, doors and fresh air intake louvers.
- Some members of our community are sensitive to heavy perfumes and colognes, including fragrances in soaps; please be aware of these sensitivities when in and around your colleagues and the college community.
- It is not a good idea to install carpets in high traffic areas, as carpets trap and concentrate contaminants tracked in from outdoors. In addition, carpet is not a good floor covering in high traffic areas for reasons of durability, aesthetics, and maintainability. For these reasons, please don't ask us to install carpets in high traffic areas.
- 16% of the air quality complaints we received over the past decade were found to be caused by rotting food odors! Please dispose of food waste to minimize mold and odors.

What chemicals are used in Custodial Services?

The chemical used by custodians to maintain the cleanliness of our indoor spaces have an impact on Indoor Environmental Quality. One important focal point of the 2002-2003 Custodial Program Review was a comprehensive analysis of the cleaning chemicals used. We implemented a culling of products (some dangerous and unnecessary) that had stockpiled over the years in custodial closets and warehouses. We also developed a universal list of the products we use regularly, with the intent of standardizing our training program on chemical safety (including the maintenance of MSDS documentation), simplifying the procurement process, obtaining volume pricing for best economy, and maximizing worker safety and environmental health. Proposed products were field-tested and evaluated by our custodians, and MSDS documentation was reviewed for compliance with worker safety and environmental health goals.

Today, our custodians undergo a weekly safety training program. Our MSDS documentation is current. Our inventory of cleaning chemicals is limited to a maximum of 4 months' worth of a limited number of products, as follows:

- GENERAL PURPOSE CLEANERS
  - Abrasive Cleanser with Bleach
  - Acid Bowl Cleaner
  - All purpose Heavy Duty Neutral Cleaner
  - Bowl Cleaner
  - Citrus Cleaner - Metal & Porcelain
  - Dust Mop / Cloth Treatment
  - General Purpose Cleaner
  - Glass Cleaner
  - Graffiti Remover
  - Heavy Duty Cleaner
  - Water Soluble Liquid Deodorizer
  - Bleach
  - Quaternary Disinfectant Cleaner/Deodorizer
  - Water-based Degreaser
  - Furniture Polish
  - Stainless Steel Cleaner/Polish
  - Liquid Hand Soap
- CARPET CLEANERS
  - Pre-Spray Carpet Cleaner Treatment
  - PS-460 Traffic Lane Cleaner
  - Chemical Defoamer
  - Carpet Spot Remover
  - Spin Bonnet Cleaner
  - Extraction Cleaner
- WAX/SEALERS
  - Floor Wax/Finish
  - Sealer - Water Based
  - Sealer - Solvent Based
- HARD FLOOR CLEANERS
  - Floor Restorer
  - Stripper

In 2006, the Facilities Department is scheduled to re-evaluate its custodial products supply vendor because the current contract (effective 2003 – 2006) will expire. We will take this opportunity to give serious consideration to the incorporation of Green Seal certified custodial chemical products, such as citrus-based cleaners, to further enhance our commitment toward worker safety and environmental health.

How does the use of Stratica resilient flooring improve indoor environmental quality?

Stratica resilient flooring tile is SMCCCD's standard flooring product because of its environmental benefits, its sophisticated appearance, as well as its favorable life cycle cost.

Stratica Eco-Polymeric Flooring is plastizer-free flooring, available in tile and strips to the commercial market only. Stratica features a new chlorine-free surface wear layer, based on a DuPont polymer called Surlyn®. It emits no VOCs, and is lightweight, practical to handle and both quick and easy to install. The special construction of the backing ply means that Stratica has exceptionally low smoke density and toxicity values. Stratica is highly resistant to blood, urine, methylene blue and a wide range of chemical agents and it is more resistant than most resilient flooring to betadine solution. It is

also mildew and odor resistant. Stratica flooring has met the requirements of the new FloorScore testing program, a voluntary certification program that identifies flooring products that meet stringent air-quality requirements.

Unlike other resilient flooring, Stratica does not need to be stripped or waxed for its protection. Cleaning is simple: just a neutral detergent and a mop and

bucket. The neutral detergent and water method of cleaning is more environmentally friendly than floors that must be stripped and waxed with harsh chemicals. It's better for our custodians, and it's better for our building occupants.

Stratica resilient flooring's appearance is sophisticated and natural; although a synthetic material, its appearance imitates natural materials such as stone, marble, terrazzo and wood. The matte wear layer is made of Surlyn®, which is the same material applied to golf balls.

The 30 year life cycle cost of Stratica is $12.50/sf versus $46.50/sf for vinyl composition tile. This economic benefit is critical in this era of diminishing operating funds and competing priorities.

SMCCCD's experience with initial Stratica installations is favorable. Faculty have found that the flooring is quieter than traditional vinyl floors, reducing footfall noise disruptions to the learning environment. Faculty have also found that the flooring is softer, reducing leg strain when standing during instruction.

SMCCCD is in good company with our decision to standardize on Stratica resilient flooring: both Kaiser Permanente and the U.S. Navy have standardized on Stratica flooring. Kaiser's primary reasons for doing so were related to their concerns about the health effects of PVC in vinyl flooring and the health effects of chemicals associated with maintaining vinyl floors. The U.S. Department of the Navy has standardized on Stratica flooring for its decking afloat; the Navy has found the use of Stratica flooring has reduced maintenance costs by 50%, and improved quality of life for sailors.

How does Collins & Aikman carpet support Indoor Environmental Quality?

SMCCCD has standardized on Collins & Aikman carpet products because of its environmental benefits, its sophisticated appearance, as well as its favorable life cycle cost.

One of the most critical factors of indoor air quality is the selection of carpeting. Some carpets and adhesives can offgas for years, causing health risks, including headaches, allergies and respiratory problems. Carpets can also be breeding grounds for molds, bacteria and dust mites, which can cause severe allergic reactions. In addition, most carpets are made of synthetic fibers from petroleum sources, which are neither renewable nor biodegradable.

Collins & Aikman carpet products have a Powerbond® backing. This backing is resistant to fluids, which makes spot cleaning of spills easier and more effective. This backing allows the carpet to be applied to the floor using dry adhesives, thereby avoiding the offgasses associated with traditional wet adhesives. The carpet's cushion is produced without harmful CFC's or HCFC's.

Like Stratica flooring, Collins & Aikman's manufacturing processes have achieved recognition for sustainability. C&A requires suppliers to eliminate carcinogens and toxins in the raw materials supplied, provide reusable packaging, and send all scrap to recycling centers. Office paper, plastic, aluminum, cardboard and yarn are recycled as part of an aggressive in-house recycling program. The company has initiated a self-imposed environmental audit program to remove impurities from their manufacturing facilities and their end product. Collins & Aikman has instituted a corporate reclamation program for Powerbond and other vinyl-back floor covering after its useful life. The carpet is collected and processed into other products, including parking stops and industrial flooring.

Collins & Aikman carpets improve SMCCCD's indoor environmental quality by emitting nearly undetectable VOCs. In addition, special carbon-core filaments are embedded in the carpet fibers, which provide permanent static control. (Competing carpet products often only have a topical treatment for static control – which wears off over time.) Static control makes the carpeted environment more friendly for people as well as electronic equipment.

Each of our colleges has standardized on several Collins & Aikman carpet products that complement their overall architectural color and finish palettes. The products selected include large and small pattern, timeless and elegant carpets that will serve the colleges for many years to come.

Collins & Aikman carpet is warranted for a non-prorated period of twenty-five years against typical carpet failures, such as excessive wear, excessive static electricity, resiliency loss of the backing, delamination, edge ravel, and zippering.

How do our painted interior surfaces contribute to Indoor Environmental Quality?

Paint and sealers cover a large amount of surface in a building, and therefore have a significant impact on indoor air quality. There are two major types of paint products: petroleum solvent-based oil paints and water-based paints. Solvent-based paints contain large amounts of toxic chemicals and produce a great deal of hazardous vapors. Water-based paints are generally less hazardous to handle, but can still contain toxic ingredients. Water-based paints are the safest option for the people who handle them and the environment. For this reason, SMCCCD has standardized on latex (water based) paints for the indoor environment.

Latex paints have a less objectionable odor, which makes them good for repaints and painting in occupied areas, where solvent odor is an issue. They clean up with soap and water; there's no need to work with hazardous and/or flammable solvents, and no used solvent to dispose of afterwards. Latex paints dry faster, and can be recoated sooner; this makes them a good choice for painting in occupied areas, where someone might touch or brush up against the freshly painted surface. Latex paint binders hold up better in sun-exposed areas, because they're more resistant to UV (ultraviolet) radiation; alkyd and oil binders will absorb more of this radiation and break down more quickly. Latex paint films are less prone to yellowing over time, especially with white, light off-white and pastel colors. Latex paint films are more breathable; they allow small amounts of water vapor to pass through the film, so the chance of blistering is reduced. This is especially important when the surface being painted is slightly damp. Latex paint films have better gloss and color retention, so they'll keep a 'like-new' appearance longer. Latex paint films are more elastic, so they can expand and contract

with the substrate better; this means they'll be less likely to crack and peel over time.

Each of our colleges has standardized on several paint colors that complement their overall architectural color and finish palettes. The colors selected include the basic timeless elegance of bone white, together with some exciting accent colors that will add interest to the indoor environment and serve the colleges for many years to come.

How do our acoustical ceiling panels contribute to Indoor Environmental Quality?

SMCCCD has standardized on USG Millennia ClimaPlus and Radar acoustical ceiling panels because of their environmental benefits in our learning environments as well as the company's commitment to environmental manufacturing processes.

USG Millennia ClimaPlus and Radar ceiling panels are mineral fiber and wood fiber ceiling tiles containing recycled material. The recycled materials are primarily slag wool and cellulose fiber. Slag wool is made from a recycled waste product of steel production. Cellulose fiber is made from recycled newsprint. Millennia ClimaPlus ceiling panels have 80% recycled content. The panels have corn and wheat starches as binders, in lieu of petroleum-based chemical binders typically used in such panels. The ceiling suspension systems have 25% recycled steel content, and they can be recycled completely at the end of their lifecycle.

USG has used environmental control equipment since before the Clean Air Act was passed in 1969. Their plants consume clean fuel, such as natural gas or low-sulfur oil, wherever possible. Water treatment equipment in their plants recycles water, reducing effluent discharges to municipal treatment systems. They reuse heat from the drying process to provide hot water and to heat other parts of the plant.

The acoustical properties of our ceiling panels enhance our learning environments. Millennia's noise reduction coefficient (NRC), a measure of how much noise or sound is absorbed when the sound waves strike the face of the ceiling panel, is .70. NRC ratings fall between .2 and .8, so our Millennia panels do a great job of attenuating acoustics in our classrooms.

The light reflectance (LR) properties of ceiling panels also enhance our learning environments by providing a surface that bounces available light (whether daylight or mechanical light). Millennia's LR rating of .85, and Radar's LR of .84 are very good (compared to similar products that range in LR values from .69 to .90). This means that the available light in our learning and working environments will softly reflect off our ceilings, lessening the need for more energy-consuming mechanical lighting as well as eliminating the additional heat load from light fixtures (which would then have to be mechanically cooled).

How do our window treatments contribute to Indoor Environmental Quality?

Window treatments serve multiple functions, including solar shading, glare reduction, thermal insulation, and provision of privacy.

SMCCCD's standard for window treatments is comprised of a number of components: roller shades, blackout curtains, and horizontal blinds.

Our standard roller shade is made by Mechoshade. These shades have a transparency to them, allowing a visual connection to our beautiful exterior environments, while still reducing eye strain associated with glare and providing privacy. They reduce heat gain when it's hot outside and heat loss when it's cold, improving occupant comfort. Their flat surface and washable fabric are easy to clean, allowing for ease of maintenance and ensuring that dust is minimized in our indoor environments. Damaged fabric can be easily replaced by local staff over the coming decades, reducing the total cost of ownership. The roller shade's level of transparency provides adequate light control to allow for visual projection in our classrooms that will have ever-increasing reliance on technology to support modern pedagogy.

Certain classrooms will also receive blackout curtains, for enhanced room darkening capability. Certain art and science classrooms require absolute room darkening to support instruction.

In few instances, horizontal blinds are the window treatment of choice. While the functionality and durability of horizontal blinds don't meet our stringent criteria in most applications, in certain non-demanding installations their low cost makes them a viable solution.

How does the new furniture affect Indoor Environmental Quality?

SMCCCD's commitment to comfortable, functional, durable and healthy interior environments includes well-considered furniture selection. In 2003 – 2004, extensive research was done to identify furniture manufacturers whose products are suitable for SMCCCD's varied applications, whose manufacturing processes met our sustainability goals, and who would provide value-added services over and above simply selling their goods to us. Furniture fairs provided an extensive and inclusive process by which faculty, staff, students and administrators were able to assist in selection of standard furniture items. Those items that have been selected can be found at Furniture.

There is a great awareness of ergonomics in the working and learning environment. Ergonomics was an important criteria in selection of standard furniture items. Many standard furniture pieces have ergonomic features built in, such as manual crank height adjustability for working surfaces which allows for greater individual comfort, contributing to a healthier work environment. To supplement the ergonomic features of furniture, ergonomic tools – such as keyboard trays and monitor arms – are also available. SMCCCD's standard ergo tools can be found at Ergonomic Tools.

We sought furniture manufacturers who are committed to environmental sustainability. The following specifications demonstrate that commitment. Of particular interest in terms of indoor air quality is the low VOC, water-based adhesives used in manufacturing:

- Metal components of furniture contains an average of 30% recycled content, with 70% of that content being post-consumer recycled.
- Major suppliers of wood products are committed to the Sustainable Forestry InitiativeSM program and works with landowners to ensure that any forestry activity is responsibly conducted to protect the ability of the landowner to continue to grow forests for future generations. The particleboard and medium density fiberboard manufacturing facilities have certified (per Scientific Certification Systems) that that products are composed of 100% recycled and recovered fiber, with at least 90% post-industrial recycled content and the balance recovered content, on a dry-fiber basis.

- Although polypropylene consists of virgin material and does not currently contain any recycled material but is 100% recyclable.
- The primary adhesive used to bond seat cushion foam to surfaces and bond layers of the worksurfaces is water-based, containing less than 0.4% volatile organic compounds.
- Decorative Chromium electroplating system has been optimized to reduce air emissions, reduce the hazardous and solid waste, recover and reuse nickel, etc.
- Powdercoating process lines use water-based cleaning systems prior to powder painting to clean parts as opposed to solvent-based cleaning systems. Powder coatings are baked on to the metal components, using natural gas fired ovens. Powder coatings contain negligible VOC and Hazardous Air Pollutant (HAP) contents. Add-on pollution control equipment is not necessary given the very low levels of pollutants.
- Laminates contain approximately 10% waste paper by-product.

Finally, SMCCCD receives very favorable pricing from its furniture vendors, based on our volume. Additionally, the furniture vendors provide rebates, student scholarships, and provide other value-added services such as design and training.

Indoor Environmental Quality

San Mateo County Community College District

FPO Training Module

Facilities Planning & Operations

Month, Year

Our Mission

- The **mission** of the Facilities Planning & Operations Department is to ensure a **safe**, **effective**, and **inspiring** physical environment that supports and enhances the instructional mission of the San Mateo County Community College District.

What is Indoor Environmental Quality (IEQ)?

- Indoor air quality (IAQ)
  - adequate levels of ventilation
  - thermal comfort (not too hot or cold)
  - Ventilation comfort (not too stuffy or drafty)
  - minimal levels of airborne contaminants, including odors
- Aesthetics: color and style
- Ergonomics
  - Adequate space, well organized
  - Adjustable for differently-sized people
- Acoustics: audibility, privacy
- Visual Quality: color and quality of light, glare
- Other
  - Cleanliness
  - Vibrations

Why is IEQ important?

- Most people spend about 90% of their time indoors
- Over the past 50 years, indoor air pollution has increased
- Indoor Air Pollution is ranked by the EPA as one of the four top environmental risks to the public

How does Poor IEQ Affect Our Customers?

- Increases the chances for long-term and short-term health problems for students and staff
- Impacts the student learning environment, comfort and attendance
- Reduces productivity of faculty and staff due to discomfort, sickness, or absenteeism

Why is IEQ Important to Us?

- Good IEQ is a positive indicator that our facilities are operating effectively, and that we're preserving the physical assets
- Repercussions of Poor IEQ:
  - Disruptive to operations
  - Strained customer relationships
  - Damaging to our reputation
  - Potential liability for adverse health effects
  - Costs of remediation

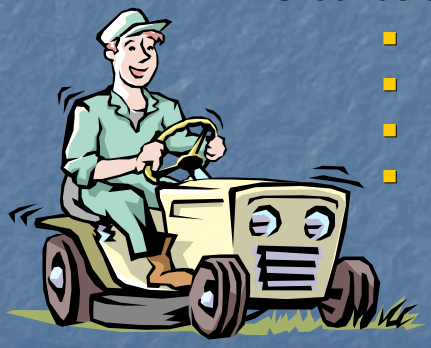
Sources of Indoor Pollutants

- Air Contaminants can begin within the building or from outdoors
- Indoor Air Quality can vary within a building or within a room
- If pollutant sources are not controlled, even if the HVAC system is working properly, poor indoor air quality will result.

Sources Outside the Building

- Emissions from nearby sources such as factories, vehicles, wood smoke, cigarette smoke, roofing smells
- Soil gas such as Radon
- Moisture
- Naturally occurring biological sources (pollen, from flowers, trees, etc.)

Sources Outside the Building

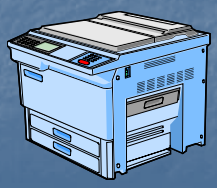


- Grounds and construction equipment
  - Backpack blowers
  - Street sweepers
  - Lawnmowers
  - Engine driven equipment (chain-saws, tractors, construction equipment, etc.)

Sources Inside the Building

- HVAC system
  - Improper venting and filtration

- Emissions from Office Equipment
  - Printers
  - Copiers
  - Fax machines
  - Laminating machines



Sources Inside the Building

- Custodial Services
  - Cleaning chemicals
  - Vacuums (stir up dust)
  - Sweeping (stir up dust)

Sources Inside the Building:
Human Activities

- Smoking
- Perfume, cologne
- Body odor
- Shampoo
- Soap
- Food odors
- Scented candles
- Incense

Sources Inside the Building:
Building Components and Furnishings

Carpets
Resilient flooring
Furniture

Sources Inside and Outside:
Construction Activities

- Roofing
- Painting
- Welding and soldering
- Dust
- Hazardous materials
  - Asbestos
  - Lead-based paints

Those touchy situations . . . Biological Growth

- **Fungus** - microscopic organisms that are part of our everyday world. The several species of fungi include mold, mildew and mushrooms. Certain forms have proven to be beneficial to humans. Beer, bread and penicillin are all made from fungi.
- **Mold** - a fungus that produces a superficial growth on various kinds of damp or decaying organic matter
- **Mildew** - fungi that grow on plants or the white growth that causes diseases in plants

Indoor Air Quality

- Indoor air often contains a variety of contaminants at concentrations that are far below any standards or guidelines for occupational exposure (also known as PELs – Permissible Exposure Limits)

Symptoms commonly attributed to poor IAQ

- 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

Building Occupant Susceptibility

Some groups that may be particularly susceptible to effects of indoor air contaminants include:

- Individuals with allergies or asthma, or people with high sensitivity to chemicals
- People with respiratory disease
- People whose immune systems are suppressed due to radiation or chemotherapy, or disease
- Contact lens wearers
- "… the fear of IAQ problems and reports of Sick Building Syndrome are generally not caused by exposure to poor IAQ, but rather to combined effects of various physical environmental and non-environmental factors"

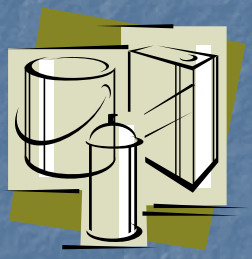
~ (Dr. Alan Hedge, Cornell University, 1996)

Poor IAQ Indicators

There are clues that can serve as indicators of potential indoor air problems:

- The symptoms are widespread within a segment of our population
- The symptoms disappear when the students or staff leave the premises for the day
- The onset is sudden after some change, such as painting or pesticide application
- Persons with allergies, asthma, or chemical sensitivities have reactions indoors but not outdoors
- A doctor has diagnosed a student or staff member as having an indoor air-related illness

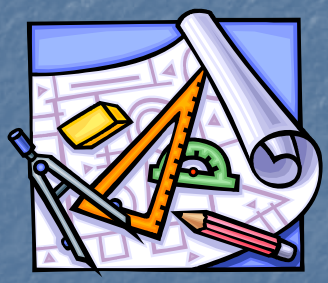
Cause and Effect



It is difficult to relate complaints of specific health effects to exposures to specific pollutant concentrations

- We are not medically trained
- We don't know what our building occupants are exposed to outside of our environment
- There is too much uncertainty at the preliminary stages to know the effect and to correlate it to a cause

How do we ensure good IEQ?



- Design Standards
  - Carpet
  - Resilient flooring
  - Paint
  - Acoustics
  - Window treatments
  - Lighting
  - Furniture
  - Ergonomics
  - Digital building management system
  - Space standards
  - Color palettes

How do we ensure good IEQ?

- Maintenance Activities
  - Daily Custodial Services
  - Preventive Maintenance Program
    - HVAC
    - Roofing
    - Building Envelope
    - Windows
    - Restrooms
    - Drinking Fountains
    - Walls, Floors, Ceilings
    - Lighting
  - IEQ Training
  - Reactive guidelines

Things *Everyone* Can Do

- Do not block air vents or grilles
- Comply with the smoking policy
- Clean up all water spills promptly, water and maintain office plants properly and report water leaks right away
- Dispose of garbage promptly and properly
- Store food properly
- Notify the Facilities Department immediately if you suspect an IAQ problem

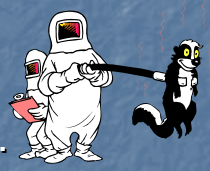
What do we do upon receipt of an IEQ concern?

- Listen, listen, listen (listen broadly, not narrowly)
- Do not assume anything
- Investigate
- Plan course of action
- Communicate
- Implement
- Reassess
- Closure

"Oh, my goodness, I think there's a problem . . ."

Because:

- I smell something . . .



- I see something . . .

- I feel sick . . .

Our Reaction

- We react quickly to concerns about EQ because we want our customers to:
  - be safe

  - feel safe

  - know that the Facilities Department is effective and responsive

- We want to stop the spread of misinformation

Our response will determine how our constituents react

- By being:
  - Responsive
  - Understanding
  - Empathetic
- Our constituents:
  - Will not overreact
  - Will feel comfortable
  - Will rely upon us to properly handle the situation

Our Responsibility

- Do not de-escalate
- Do not escalate
- Handle in a professional, diligent, sensitive manner

- Use IAQ Complaint Investigation Checklist as a guideline

Investigate Immediately

A complaint or concern is voiced

- Listen to concern
- Ask questions
  - What do you see or smell?
  - Where do you see or smell it?
  - How long have you seen or smelled it?
  - When does it occur?
  - Is there anything occurring around you which may be the cause?
  - How do you feel? (Be careful when asking this question – because we are not doctors, and we don't want to compromise medical privacy. We might ask this question if the response is useful in helping us diagnose the problem.)

Investigate Immediately

- Use IAQ Complaint Investigation Checklist as a guideline for due diligence
- If deemed necessary, testing/analysis may occur. Contact one of SMCCCD's industrial hygienists for assistance (air testing, material testing, consultation, education/outreach).

Diagnosing IEQ Problems

Diagnosing symptoms that relate to IEQ can be tricky:

- Acute (short-term) symptoms of IAQ problems typically are similar to those from colds, allergies, fatigue, or the flu
- A lack of symptoms does not mean that the quality of the environment within our buildings is acceptable
- Symptoms from long-term health effects (such as lung cancer due to radon, or ill effects of exposure to asbestos) often do not become evident for many years
- Did exposure occur at SMCCCD or elsewhere?
- Does the individual have an ulterior motive?

Mitigation and Remediation

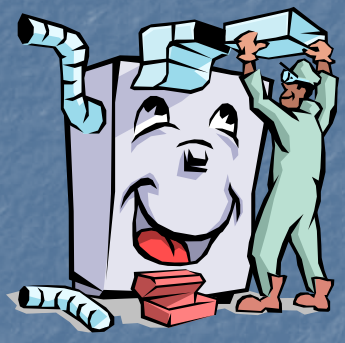
- Mitigation
  - To make (something) less harmful, unpleasant or bad
- Remediation
  - The act or process of correcting a fault or deficiency

Prevention Strategies

- Ventilation and filtration
- Source management
- Local exhaust
- Exposure control
- Education

Training Scenarios

- An opportunity to become familiar with the IAQ Complaint Investigation Checklist
- An Opportunity to reinforce the concepts that we've learned about IEQ
- Please get into groups of 5
  - IEQ Trainer will assign a Scenario
  - Discuss what your response would be to the Scenario
  - After 15 minutes, your group will present your Scenario and response to the class



Training Scenario #1

A Cosmetology instructor complains that she is getting headaches at work. She works at Skyline's Pacific Heights building.

Training Scenario #2

The President's administrative assistant at College of San Mateo complains about odors coming from the roofing construction project at the building adjacent to her office.

Training Scenario #3

The faculty union's grievance officer has just called the College President to report that he's looking out his window watching a Groundskeeper – wearing a tyvek suit and a respirator – spraying chemicals on the iceplant. He is concerned that students and faculty walking on an adjacent path are being exposed to nasty chemicals.

Training Scenario #4

The student-run College newspaper runs an article about "sick building syndrome", with an accompanying photograph of a stained ceiling tile in Cañada College's Building 22. The ceiling tile in the photograph has dark, splotchy stains on it, and the caption says that it is mold.

Questions, Comments, Feedback

PM #:		HV.1				
AIR COMPRESSORS						
		PM FREQUENCY				
		W	M	Q	S	A
1	Inspect condition and operation.	X				
2	Test oil pump operation: check for leaks and oil level - add when low.	X				
3	Perform noise/vibration test.		X			
4	Inspect shaft seal.		X			
5	Measure voltage & amperage.					X
6	Check condition and operation of Safety Relief Valves.				X	
7	Inspect drive belts/couplings. Check condition/tightness of belts; check alignment; look for black powder residue around motor, base, etc.			X		
8	Check condition of sheaves for grooves.				X	
9	Drain tank.	X				
10	Check auto-drain.		X			
11	Change air filter; change oil.					X
12	Replace intake air cleaner cartridge and end felts.					
13	Check lead-lag, if applicable.		X			
14	Check Percent on Time.				X	
15	Check operation of receiver pressure and regulator output pressure.			X	X	X
16	Check cut in/out pressures.					X
17	Check condition and operation of all pressure relief valves to include actuating the valve to relieve pressure for 10 seconds.				X	X
18	Blow down equipment to clean.					X
19	Check and record "hours run" readings, where applicable.					
20	Fill out maintenance checklist and report deficiencies.		X	X	X	X

PM #:	HV.2				
AIR CONDITIONERS					
		PM FREQUENCY			
	W	M	Q	S	A
1 EVAPORATOR / AIR HANDLING				X	X
- check condition and operation, including:					
- fans, pulleys and belts, especially for alignment; tension and wear;					
2 CONDENSER				X	X
Air Cooled:					
- check to ensure fittings are secure;					
- check condition and operation of fan, including controls.					
Water Cooled:					
- check and record operating, exit and entry water pressures and temperatures;					
- check all water connections especially for signs of leaks.					
3 REFRIGERANT SYSTEM				X	X
- check and record refrigerant operating pressures and temperatures;					
- check for refrigerant leaks in components and connections;					
- check crankcase heaters;					
- check pipework system for secure fittings.					
4 CONTROLS				X	X
- check thermostats and set-points; check safety controls and devices.					
5 ELECTRICAL					X
- check all safety devices;					
- check all connections for security, tightness, contact and corrosion;					
- check relays and contactors;					
- check all overloads and circuit breakers;					
- check all indicator lights;					
- check compressor and fan motors and record current draw at full operating load and compare with rated output;					
6 DUCTWORK					X
- check condition of flexible connections;					
- check condition of surface coatings, especially for corrosion.					
7 VARIABLE AIR VOLUME (V.A.V. BOXES)					
- check the ductwork surrounding the unit to ensure there is no excessive leakage or movement;					X
- check and modulate the t-stat to verify correct control and actuator operation;					X
- check and clean all electrical controls and pressure switches;					X
- check all linkages for secure fitting and for ease of movement, lubricate where necessary;					X
- check fan and motor for correct operation, where applicable.					X
8 Fill out maintenance checklist and report deficiencies.				X	X

PM #:	HV.3				
AIR HANDLING UNITS					
	PM FREQUENCY				
	W	M	Q	S	A
25 to 50 Ton					
1 Check with operating or area personnel for deficiencies.			X	X	X
2 Check controls and unit for proper operation.			X	X	X
3 Check for unusual noise or vibration.			X	X	X
4 Clean coils, evaporator drain pan, blower, motor and drain piping, as required.					X
5 Lubricate shaft and motor bearings.			X	X	X
6 Check belts for wear, proper tension and alignment; adjust as necessary.			X	X	X
7 Inspect exterior piping and valves for leaks; tighten connections as required.			X	X	X
8 Check operation and clean dampers, louvers and shutters; lubricate all pivot points and linkages.					X
9 Replace air filters.			X	X	X
10 Clean area around equipment.			X	X	X
11 Fill out maintenance checklist and report deficiencies.			X	X	X
3 to 24 Ton					
1 Check with operating or area personnel for deficiencies.			X	X	X
2 Check controls and unit for proper operation.			X	X	X
3 Check for unusual noise or vibration.			X	X	X
4 Check tension, condition and alignment of belts; adjust as necessary.			X	X	X
5 Clean coils, evaporator drain pan, blower, motor and drain piping, as required.					X
6 Lubricate shaft and motor bearings.			X	X	X
7 Replace air filters.			X	X	X
8 Inspect exterior piping and valves for leaks; tighten connections as required.			X	X	X
9 Clean area around equipment.			X	X	X
10 Fill out maintenance checklist and report deficiencies.			X	X	X

PM #:	HV.4				
BOILER, HOT WATER; OIL, GAS OR COMBINATION FIRED, 120 TO 500 MBH					
	PM FREQUENCY				
	W	M	Q	S	A
1 Check combustion chamber for air or gas leaks.					X
2 Inspect and clean oil burner gun and ignition assembly where applicable.					X
3 Inspect fuel system for leaks and change fuel filter element.					X
4 Check fuel lines and connections for damage.		X	X	X	X
5 Check for proper operational response of burner to thermostat controls.			X	X	X
6 Check and lubricate burner and blower motors.			X	X	X
7 Check main flame failure protection and main flame detection scanner on boiler equipped with spark ignition (oil burner).		X	X	X	X
8 Check electrical wiring to burner controls and blower.					X
9 Clean firebox (sweep and vacuum).					X
10 Check operation of mercury control switches (i.e., steam pressure, hot water temperature limit, atomizing or combustion air proving, etc.).		X	X	X	X
11 Check operation and condition of safety pressure relief valve.		X	X	X	X
12 Check operation of boiler low water cut-off devices.		X	X	X	X
13 Check hot water pressure gauges.		X	X	X	X
14 Inspect and clean water column sight glass (or replace).		X	X	X	X
15 Check condition of flue pipe, damper and exhaust stack.			X	X	X
16 Check boiler operation through complete cycle, up to 30 minutes.					X
17 Check fuel level with gauge pole; add as required.		X	X	X	X
18 Clean area around boiler.		X	X	X	X
19 Fill out maintenance checklist and report deficiencies.		X	X	X	X

PM #:	HV.5				
CHILLER, RECIPROCATING, AIR COOLED, OVER 25 TONS					
	PM FREQUENCY				
	W	M	Q	S	A
1 Check unit for proper operation, excessive noise or vibration.		X	X	X	X
2 Run system diagnostics test.		X	X	X	X
3 Check oil level in sight glass of lead compressor only; add oil as necessary.		X	X	X	X
4 Check superheat and subcooling temperatures.					X
5 Check liquid line sight glass, oil and refrigerant pressures.		X	X	X	X
6 Check contactors, sensors and mechanical safety limits.					X
7 Check electrical wiring and connections; tighten loose connections.					X
8 Clean intake side of condenser coils, fans and intake screens.					X
9 Inspect fan(s) or blower(s) for bent blades or imbalance.					X
10 Lubricate shaft bearings and motor bearings as required.					X
11 Inspect plumbing and valves for leaks, adjust as necessary.		X	X	X	X
12 Check evaporator and condenser for corrosion.		X	X	X	X
13 Clean chiller and surrounding area.		X	X	X	X
14 Fill out maintenance checklist and report deficiencies.		X	X	X	X

PM #:		HV.6				
COILS						
		PM FREQUENCY				
		W	M	Q	S	A
	EVAPORATOR					
1	Measure and record water and air resistance;					X
2	Check strainer and clean, if needed;					X
3	Check:		X			X
-	all coil pipe connections;					
-	valve condition and operation;					
-	coil face, especially for cleanliness and obstructions or damage.					
4	Check condition and operation of condensate tray and drain;		X			X
5	Fill out maintenance checklist and report deficiencies.		X			X
	CONDENSING					
1	Measure and record water and air resistance;				X	
2	Check strainer and clean, if needed;				X	
3	Check:				X	
-	all coil pipe connections;					
-	valve condition and operation;					
-	coil face, especially for cleanliness, obstruction or any damage.					
4	Check condition and operation of condensate tray and drain;				X	
5	Fill out maintenance checklist and report deficiencies.				X	
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PM #:	HV.7				
CONDENSING UNITS					
	PM FREQUENCY				
	W	M	Q	S	A
1 PUMP					
- check condition and operation of pump, especially for signs of wear, corrosion or damage.				X	X
- check and record flow, discharge and suction readings or pump shut off head against performance curve;					X
- check condition and operation of associated valves and flexible connections, especially for deterioration and leaks;				X	X
- check seals for condition/leaks.					
2 MOTOR					
- check condition and operation of motor, especially for signs of any overheating, wear, corrosion or damage.				X	X
3 PUMP AND MOTOR					
- check condition and operaion of connection between pump and motor;				X	X
- check and clean exposed surfaces, gland, pump and housing;				X	X
- check condition and security of all fittings and mountings;				X	X
- check condition of paint or protective coating/s.				X	X
4 ELECTRICAL					
check condition and operation of all controls including:					X
- isolating switch and conduit for security of mounting;					X
- all connections for security, tightness, contract and corrosion;					X
- check ground wire continuity.					
5 LINE STRAINER					
- check condition and clean.					X
- check condition and operating of condensate drain or drip tray.					X
6 Fill out maintenance checklist and report deficiencies.				X	X

PM #:		HV.8				
COOLING TOWER, FORCED DRAFT, 50 TONS TO 499 TONS						
		PM FREQUENCY				
		W	M	Q	S	A
1	Check with operating or area personnel for deficiencies.				X	X
2	Check operation of unit for water leaks, noise or vibration.				X	X
3	Clean and inspect hot water basin.				X	X
4	Remove access panel.				X	X
5	Check electrical wiring and connections; make appropriate adjustments.				X	X
6	Lubricate all motor and fan bearings.				X	X
7	Check fan blades or blowers for imbalance and tip clearance.				X	X
8	Check belt for wear, tension and alignment; adjust as required.				X	X
9	Drain and flush cold water sump and clean strainer.				X	X
10	Clean inside of water tower using water hose; scrape, brush and wipe as required. Heavy deposits of scale should be removed with scale-removing compound.				X	X
11	Refill with water; check make-up water assembly for leakage. Adjust float if necessary.				X	X
12	Replace access panel.				X	X
13	Remove, clean and reinstall conductivity and pH electrodes in chemical water treatment system.				X	X
14	Inspect and clean around cooling tower.				X	X
15	Fill out maintenance checklist and report deficiencies.				X	X

PM #:		HV.9				
FAN COIL UNITS						
		PM FREQUENCY				
		W	M	Q	S	A
1	Check condition and operation of filters;			X		X
2	Check to ensure drains and condensate trays are clear, where applicable;			X		X
3	Check condition and operation of coils, especially for cleanliness and obstructions;			X		X
4	Check pipework and connections, especially for leaks;			X		X
5	Check unit mounting, fittings and for unusual vibrations;					X
6	Check condition and operation of fan motor, to include:					X
-	bearings, lubricate if needed;					
-	check and record current operating draw;					
7	Check condition and security of all electrical wiring and connections, especially for tightness, contact and corrosion;			X		X
8	Fill out maintenance checklist and report deficiencies.			X		X
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PM #:		HV.10				
FANS						
		PM FREQUENCY				
		W	M	Q	S	A
	AXIAL					
1	Start and stop fan with local switch.				X	X
2	Check motor and fan shaft bearings for noise, vibration, overheating; lubricate bearings.				X	X
3	Check belts for wear, tension and alignment, if applicable; adjust as required.				X	X
4	Check fan pitch operator; lubricate, if applicable.				X	X
5	Check electrical wiring and connections; tighten loose connections.				X	X
6	Clean fan and surrounding area.				X	X
7	Fill out maintenance checklist and report deficiencies.				X	X
	FUME HOODS/UTILITY/EXHAUST					
1	Start and stop fan with local switch.				X	X
2	Check motor and fan shaft bearings for noise, vibration, overheating; lubricate bearings.		X	X	X	X
3	Check belts for wear, tension and alignment, if applicable; adjust as required.				X	X
4	Check flexible duct connectors.		X	X	X	X
5	Check electrical wiring and connections; tighten loose connections.				X	X
6	Clean fan and surrounding area.				X	X
7	Fill out maintenance checklist and report deficiencies.		X	X	X	X
	ROOF/WALL EXHAUST					
1	Start and stop fan with local switch.				X	X
2	Check for loose or missing housing fasteners; tighten or replace as necessary.		X	X	X	X
3	Check motor and fan shaft bearings for noise, vibration, overheating; lubricate bearings.				X	X
4	Check belts for wear, tension and alignment, if applicable; adjust as required.				X	X
5	Check electrical wiring and connections; tighten loose connections.				X	X
6	Clean fan and surrounding area.				X	X
7	Fill out maintenance checklist and report deficiencies.		X	X	X	X

PM #:	HV.11				
FILTERS - REPLACEABLE					
	PM FREQUENCY				
	W	M	Q	S	A
1 Check condition and operation of filters, especially for: cleanliness; pressure drop across media; obstructions; damage or deterioration.		X			
2 Check filters and seals between filter units, especially for leakage;		X			
3 Check condition of filter frames and frame supports, especially for signs of damage or deterioration;		X			
4 Fill out maintenance checklist and report deficiencies.		X			

PM #:	HV.12				
HEAT EXCHANGER					
	PM FREQUENCY				
	W	M	Q	S	A
1 Check condition and operation, to include:					
				X	X
- pipework and connections for leaks and corrosion;					
- all safety devices;					
- all controls, thermostats and set-points; for correct heat exchange across system;					
- check and record primary water temperature;					
- check and record secondary water temperature.					
2 Dismantle, clean and check exchanger for:					X
- gaskets and mating surfaces;					
- condition of shell and tubes;					
reassemble;					
3 Fill out maintenance checklist and report deficiencies.				X	X
4					
5					
6					
7					
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12					

PM #:		HV.13				
PACKAGE UNITS						
		PM FREQUENCY				
		W	M	Q	S	A
	COMPUTER ROOMS					
1	Check with operating or area personnel for deficiencies.			X	X	X
2	Run microprocessor check, if available, or check controls and unit for proper operation.			X	X	X
3	Check for unusual noise or vibration.			X	X	X
4	Clean coils, evaporator drain pan, humidifier pan, blower, motor and drain piping as required.				X	X
5	Replace air filters.			X	X	X
6	Lubricate shaft and motor bearings.			X	X	X
7	Check belts for wear, proper tension and alignment; adjust as necessary.			X	X	X
8	Check humidity lamp; replace if necessary.			X	X	X
9	During operation of unit, check refrigerant pressures; add refrigerant as necessary.				X	X
10	Inspect exterior piping and valves for leaks; tighten connections as required.			X	X	X
11	Clean area around unit.			X	X	X
12	Fill out maintenance checklist and report deficiencies.			X	X	X
	ROOF UNITS					
1	Check tension, condition and alignment of belts; adjust as necessary.			X	X	X
2	Lubricate shaft and motor bearings.			X	X	X
3	Replace air filters.			X	X	X
4	Clean electrical wiring and connections; tighten loose connections.					X
5	Clean coils, evaporator drain pan, blowers, fans, motors and drain piping as required.					X
6	Perform operational check of unit; make adjustments on controls and other components as required.			X	X	X
7	During operation of unit, check refrigerant pressure; add refrigerant as necessary.			X	X	X
8	Check compressor oil level; add oil as required.					X
9	Clean area around unit.			X	X	X
10	Paint, as needed.					
11	Fill out maintenance checklist and report deficiencies.			X	X	X

PM #:		HV.14				
PNEUMATIC CONTROLS						
		PM FREQUENCY				
		W	M	Q	S	A
1	Check calibration of room/space temperature sensors.		X	X	X	
2	Check operation of all control switches.			X	X	
3	Check calibration of all unit controllers.				X	
4	Check condition and operation of all heating/cooling control valves and gland bodies especially for leaks.				X	
5	Check condition and operation of all modulating motors.			X	X	
6	Check operation of fan speed controllers.				X	
7	Check condtion and operation of all damper motors.			X	X	
8	Fill out maintenance checklist and report deficiencies.		X	X	X	
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PM #:	HV.15				
PUMPS					
	PM FREQUENCY				
	W	M	Q	S	A
	PRIMARY				
1 Check blower motors . Grease bearings and shaft. Vacuum the electric motor cooling fan.				X	
2 Blow out variable drive control cabinet with compressed air. a) Visually check condition of capacitors b) check if melted or heat discolored.					X
3 Check control cabinet lights - replace if burned out.				X	
4 Change filters.			X		
5 Check condition of belts for tightness.					X
6 Check condition of sheaves for grooves.					X
7 Check coils for build-up/matting. Vacuum, if needed.					X
8 Check hydronic line strainers. Blow down strainer valve (wear safety glasses). Water should be clean and free of debris. Should have good flow - same diameter as pipe.					X
9 Check condensate pans. Look for water build-up (not holding water). Inspect for proper drainage.					X
10 Fill out maintenance checklist and report deficiencies.			X	X	X
	VACUUM				
1 **PUMP**					
- check condition and operation of pump, especially for signs of wear, corrosion or damage;				X	X
- check oil level in resevoir and ajdust, if needed;			X	X	X
- check condition and operation of associated valves and flexible connections, especially for deterioration or leaks;				X	X
2 **MOTOR**					
Check condition and operation of motor, especially for signs of overheating, wear, corrosion or damage;				X	X
3 **PUMP AND MOTOR**					
- check condition and operation of connection between pump and motor;				X	X
- check condition and security of all fittings and mountings;				X	X
- check condition of paint or protective coatings.				X	X
4 **ELECTRICAL**					
Check condition and operation of all controls, to include:					X
- isolating switch and conduit for security of mounting;					X
- all connections for security, tightness, contact and corrosion;					X
- check ground wiring continuity.					X
5 Check condition and operation of condensate drain.			X	X	X
6 Fill out maintenance checklist and report deficiencies.			X	X	X

PM #:		HV.16					
RADIANT HEATER							
		PM FREQUENCY					
		W	M	Q	S	A	
1	Clean heater of dust and debris;				X		
2	Clean filter;				X		
3	Check electrical connections including operation of fan speed switch;				X		
4	Check fans for:				X		
-	vibration;				X		
-	dust build-up.				X		
5	Check all water connections for leaks;				X		
6	Check coils for cleanliness, condition of fins, and coil header for corrosion or leaks;				X		
7	Exercise thermostatic valve, if applicable;				X		
8	Check heater for correct operation;				X		
9	Fill out maintenance checklist and report deficiencies.				X		
10							
11							
12							
13							
14							
15							

PM #:	HV.17				
SPACE HEATER - GAS FIRED					
	PM FREQUENCY				
	W	M	Q	S	A
1 Check condition and operation of all safety devices;					X
2 Check condition and operation of all controls;					X
3 Check condition and operation of appliance, to include:					X
- pipework, especially for leaks;					
- isolating valve/s;					
- heating panels;					
- reflectors;					
- ceramic tiles;					
- ignition system;					
- circulation fans.					
4 Clean and remove all foreign matter from inside of appliance;					X
5 Remove and clean pilot injector tips;					X
6 Test run appliance to ensure correct operation after all service work has been completed;					X
7 Fill out maintenance checklist and report deficiencies.					X
8					
9					
10					
11					
12					
13					
14					
15					

PM #:	HV.18				
WATER HEATERS					
	PM FREQUENCY				
	W	M	Q	S	A
1 GAS					
Check both the temperature and pressure relief valves and ensure lever is functioning;					X
Open drain valve and drain 1-2 gallons of water to remove sediment;				X	
Inspect insulation to ensure it is still in proper position and not blocking combustion air inlet or exhaust vent;					X
Check temperature setting ;			X		
Fill out maintenance checklist and report deficiencies.					
2 ELECTRIC					
Check condition and operation of all safety valves and devices;				X	
Check unit for damage or leaks;				X	
Check storage and delivery water temperature to ensure compliance with legislative requirements;				X	
Check condition and operation of strainer/filter;				X	
Check all electrical connections;				X	
Check safety tray and overflow; if fitted;				X	
Drain unit clean of all sediment and refill with fresh water;					X
Check condition of heating element;					X
Fill out maintenance checklist and report deficiencies.				X	X

PM #:		R.1				
ROOFS						
		PM FREQUENCY				
		W	M	Q	S	A
	All Roofs					
1	Clean debris from the surface of the roof, including under, around and behind HVAC equipment.				X	
2	Clear gutters of debris. Ensure downspouts are draining properly by performing a water test. Ensure that scuppers are clear.				X	
3	Check rainwater leaders for proper connection, corrosion and check for and clear any debris.				X	
4	Water test sump drains.				X	
5	Check for any overhanging or intrusive tree branches or vines, and report deficiencies to Lead Groundskeeper.				X	
6	Check expansion joints for wear, stress cracks or damage.				X	
7	Check flashings and other metal elements for deterioration/holes. Check condition of caulking and sealants on flashings and copings.				X	
8	Check condition of skylights: look for cracks in glass/acrylic, integrity of caulking/sealant around edges, condition of flashings.				X	
9	Check condiion of roof hatch: weather strip seals, flashing to the seals, hardware.				X	
10	Check condition of equipment screens: attachments, cleanliness, deterioration, doors/gates.				X	
11	Fill out maintenance checklist and report deficiencies.				X	

	Built Up Roof - Hot Applied					
12	Check condition of asphalt surface for signs of tearing, punctures, blisters, ponding, peeling, or delamination of asphalt layers.				X	
13	If roof has gravel surface material, check that gravel is evenly dispersed in an even layer over the entire surface.				X	
14	If roof has a modified bitumen cap sheet, check for signs of tearing, punctures, blisters, or delamination.				X	
15	If roof has walk pads, check that they are attached adequately and in place.				X	
16	Check condition of pitch pockets.				X	
17	Fill out maintenance checklist and report deficiencies.				X	
	Built Up Roof - Cold Applied					
18	Check condition of asphalt surface for signs of tearing, punctures, blisters, ponding, peeling, or delamination of asphalt layers.				X	
19	If roof has gravel surface material, check that gravel is evenly dispersed in an even layer over the entire surface.				X	
20	If roof has a modified bitumen cap sheet, check for signs of tearing, punctures, blisters, or delamination.				X	
21	If roof has walk pads, check that they are attached adequately and in place.				X	
22	Check condition of pitch pockets.				X	
23	Fill out maintenance checklist and report deficiencies.				X	

	Modified Bitumen					
24	Check condition of modified bitumen surface for signs of tearing, punctures, blisters, ponding, peeling or delamination.				X	
25	If roof has walk pads, check that they are attached adequately and in place.				X	
26	Fill out maintenance checklist and report deficiencies.				X	
	Metal Roof					
27	Check metal surface panels for deterioration, rust, looseness, mechanical damage, etc.				X	
28	Check seams for deterioration, rust, looseness, mechanical damage, etc.				X	
29	Visually inspect for loose or missing fasteners.				X	
30	Fill out maintenance checklist and report deficiencies.				X	
	Composition Shingle or Other Tile Roof					
31	Check that shingles are not missing, and that they are not broken, torn, or otherwise damaged.				X	
32	Check that shingles are adequately attached.				X	
33	Check edge metal for damage.				X	
34	Fill out maintenance checklist and report deficiencies.				X	

PM #:		BE.1					
BUILDING ENVELOPE							
		PM FREQUENCY					
		W	M	Q	S	A	
	Exterior Walls						
1	Visually inspect paint or surface conditions for moisture penetration.				X		
2	Visually inspect structural frame movement causing cracks and settelement				X		
3	Check condition of caulking and mortar at construction and expansion joints.				X		
4	Visually inspect surfaces for signs of efflorescence and staining.				X		
5	Fill out maintenance checklist and report deficiencies.				X		
	Exterior Windows						
6	Visually inspect frame fittings.				X		
7	Check putty and weatherstripping.				X		
8	Check material condition of glass and metal panels.				X		
9	Check to ensure proper working condition.				X		
10	Fill out maintenance checklist and report deficiencies.				X		
	Entrances & Exits						
11	Check general condition of entries & exits for clarity from obstructions and trip hazards; ensure navigability.			X			
12	Check condition and operation of door stiles/rails and fixing of glazing material, if fitted.			X			
13	Check condition and operation of hinges, especially for secure fittings; lubricate as needed.			X			
14	Check condition and operation of lock; lubricate as needed.			X			
15	Check automatic opening device, ensure door opens freely when device is actuated.			X			
16	Check hold open devices for correct operation, where applicable.			X			
17	Check condition and operation of door closer, if equipped, and lubricate as needed.			X			
18	Check condition and operation of latch/handle/panic bar device.			X			
19	Fill out maintenance checklist and report deficiencies.			X			
	Exterior Stairs & Handrails						
20	Check stability of treads and wear and tear on non-slip surfaces.			X			
21	Check to ensure handrails are in good condition.			X			
22	Ensure that there are no obstructions above the rail that would cause a handhold to be interupted.			X			
23	Check to ensure that the handrail is continuous between stair landings.			X			
24	Fill out maintenance checklist and report deficiencies.			X			

Complaint Investigation Checklist

Indoor Air Quality

In the event of an indoor air quality complaint, use this checklist to review and eliminate sources of IAQ contaminants and identify the source of the issue. This checklist is based on the Environmental Protection Agency's *IAQ Tools for Schools Kit*.

			Yes	No	N/A	Comments
1		**TALK TO THE INDIVIDUAL(S) WHO HAS THE CONCERN**				
	a	What do you see or smell?				
	b	Where do you see or smell it?				
	c	How long have you seen or smelled it?				
	d	When does it occur?				
	e	Is there anything occurring around you which may be the cause?				
	f	How do you feel? Note: Be careful when asking this question – because we are not doctors, and we don't want to compromise medical privacy. We might ask this question if the response is useful in helping us diagnose the problem.				
2		**GENERAL CLEANLINESS**				
	a	Offices are dusted and vacuumed regularly.				
	b	Trash is removed daily.				
	c	No food is stored in the office overnight.				
	d	The room is free of pests and vermin.				
	e	Only unscented, school-approved cleaners and air fresheners are used in rooms.				
3		**EXCESS MOISTURE IN OFFICES**				
	a	There is no evidence of condensate on windows, windowsills, and window frames.				
	b	Cold water pipes are free of condensate.				
	c	Indoor surfaces of exterior walls are free of condensate.				
	d	Areas around and under sinks are free of leaks.				
	e	Lavatories are free of leaks.				
	f	Checked ceiling tiles and walls for leaks (discoloration may indicate periodic leaks).				
	g	There is no evidence of spills that did not get cleaned.				
	h	Ensured that there are no signs of mold or mildew.				
4		**THERMAL COMFORT**				
	a	Ensured moderate temperature (should generally be 72°F–76°F).				
	b	Ensured that there are no signs of draftiness.				
	c	Humidity is maintained at acceptable levels (between 30 and 60 percent).				
5		**PRINTING/DUPLICATING EQUIPMENT**				
	a	Checked for odors from equipment.				
	b	Ensured that equipment is maintained regularly (date of most recent servicing is usually documented on the machine).				
	c	Checked that equipment functions properly.				
	d	Ensured that duplicating equipment, printers, and copiers are located in a well-ventilated area, preferably in a separate room with an exhaust fan vented to the outside.				
6		**HVAC SYSTEM**				
	1	**OUTDOOR AIR INTAKES**				
	1a.	Marked locations of all outdoor air intakes on a small floor plan (for				
	1b.	Ensured that the ventilation system was on and operating in "occupied"				
		Activity 1: Obstructions				
	1c.	Ensured that outdoor air intakes are clear of obstructions, debris, clogs,				
	1d.	Installed corrective devices as necessary (e.g., if snowdrifts or leaves				
		Activity 2: Pollutant Sources				
	1e.	Checked ground-level intakes for pollutant sources (dumpsters, loading				
	1f.	Checked rooftop intakes for pollutant sources (plumbing vents; kitchen,				
	1g.	Resolved any problems with pollutant sources located near outdoor air				
		Activity 3: Airflow				
	1h.	Obtained chemical smoke (or a small piece of tissue paper or light				
	1i.	Confirmed that outdoor air is entering the intake appropriately.				
	2	**SYSTEM CLEANLINESS**				
		Activity 4: Air Filters				
	2a.	Replaced filters per maintenance schedule.				
	2b.	Shut off ventilation system fans while replacing filters (prevents dirt from				
	2c.	Vacuumed filter areas before installing new filters.				
	2d.	Confirmed proper fit of filters to prevent air from bypassing (flowing				
	2e.	Confirmed proper installation of filters (correct direction for airflow).				
		Activity 5: Drain Pans				
	2f.	Ensured that drain pans slant toward the drain (to prevent water from				
	2g.	Cleaned drain pans.				
	2h.	Checked drain pans for mold and mildew.				
		Activity 6: Coils				
	2i.	Ensured that heating and cooling coils are clean.				
		Activity 7: Air-Handling Units, Unit Ventilators				
	2j.	Ensured that the interior of air-handling unit(s) or unit ventilator (air-				
	2k.	Ensured that ducts are clean.				
		Activity 8: Mechanical Rooms				
	2l.	Checked mechanical room for unsanitary conditions, leaks, and spills.				
	2m.	Ensured that mechanical rooms and air-mixing chambers are free of trash, chemical products, and supplies.				

Complaint Investigation Checklist

Indoor Air Quality

3	**CONTROLS FOR OUTDOOR AIR SUPPLY**				
3a.	Ensured that air dampers are at least partially open (minimum position).				
3b.	Ensured that minimum position provides adequate outdoor air for occupants.				
	Activity 9: Controls Information				
3c.	Obtained and reviewed all design inside/outside temperature and humidity requirements, controls specifications, as-built mechanical drawings, and controls operations manuals (often uniquely designed).				
	Activity 10: Clocks, Timers, Switches				
3d.	Turned summer-winter switches to the correct position.				
3e.	Set time clocks appropriately.				
3f.	Ensured that settings fit the actual schedule of building use (including night/weekend use).				
	Activity 11: Control Components				
3g.	Ensured appropriate system pressure by testing line pressure at both the occupied (day) setting and the unoccupied (night) setting.				
3h.	Checked that the line dryer prevents moisture buildup				
3i.	Replaced control system filters at the compressor inlet based on the compressor manufacturer's recommendation (for example, when you blow down the tank).				
3j.	Set the line pressure at each thermostat and damper actuator at the proper level (no leakage or obstructions).				
	Activity 12: Outdoor Air Dampers				
3k.	Ensured that the outdoor air damper is visible for inspection				
3l.	Ensured that the recirculating relief and/or exhaust dampers are visible for inspection.				
3m.	Ensured that air temperature in the indoor area(s) served by each outdoor air damper is within the normal operating range.				
3n.	Checked that the outdoor air damper fully closes within a few minutes of shutting off appropriate air handler.				
3o.	Checked that the outdoor air damper opens (at least partially with no delay) when the air handler is turned on.				
3p.	If in heating mode, checked that the outdoor air damper goes to its minimum position (without completely closing) when the room thermostat is set to 85°F.				
3q.	If in cooling mode, checked that the outdoor air damper goes to its minimum position (without completely closing) when the room thermostat is set to 60°F and mixed air thermostat is set to 45°F.				
3r.	If the outdoor air damper does not move, confirmed the following items:				
	The damper actuator links to the damper shaft, and any linkage set screws or bolts are tight.				
	Moving parts are free of impediments (e.g., rust, corrosion)				
	Electrical wire or pneumatic tubing connects to the damper actuator				
	The outside air thermostat(s) is functioning properly (e.g., in the right location, calibrated correctly).				
	Proceed to Activities 13–16 if the damper seems to be operating properly.				
	Activity 13: Freeze Stats				
3s.	Disconnected power to controls (for automatic reset only) to test continuity across terminals.				
	OR				
3t.	Confirmed (if applicable) that depressing the manual reset button (usually red) trips the freeze stat (clicking sound indicates freeze stat was tripped).				
3u.	Assessed the feasibility of replacing all manual reset freeze-stats with automatic reset freeze-stats.				
	NOTE: HVAC systems with water coils need protection from the cold. The freeze-stat may close the outdoor air damper and disconnect the supply air when tripped. The typical trip range is 35°F to 42°F.				
	Activity 14: Mixed Air Thermostats				
3v.	Ensured that the mixed air stat for heating mode is set no higher than 65°F.				
3w.	Ensured that the mixed air stat for cooling mode is set no lower than the room thermostat setting.				
	Activity 15: Economizers				
3x.	Confirmed proper economizer settings based on design specifications or local practices.				
	NOTE: The dry-bulb is typically set at 65°F or lower.				
3y.	Checked that sensor on the economizer is shielded from direct sunlight				
3z.	Ensured that dampers operate properly (for outside air, return air, exhaust/relief air, and recirculated air), per the design specifications.				
	NOTE: Economizers use varying amounts of cool outdoor air to assist with the cooling load of the room or rooms. There are two types of economizers, dry-bulb and enthalpy. Dry-bulb economizers vary the amount of outdoor air based on outdoor temperature, and enthalpy economizers vary the amount of outdoor air based on outdoor temperature and humidity level.				
	Activity 16: Fans				
3aa.	Ensured that all fans (supply fans and associated return or relief fans) that move outside air indoors continuously operate during occupied hours (even when room thermostat is satisfied) .				
	NOTE: If fan shuts off when the thermostat is satisfied, adjust control cycle as necessary to ensure sufficient outdoor air supply.				

Complaint Investigation Checklist

Indoor Air Quality

4	**AIR DISTRIBUTION**				
	Activity 17: Air Distribution				
4a.	Ensured that supply and return air pathways in the existing ventilatior system perform as required.				
4b.	Ensured that passive gravity relief ventilation systems and transfer grilles between rooms and corridors are functioning. *NOTE: If ventilation system is closed or blocked to meet current fire codes, consult with a professional engineer for remedies.*				
4c.	Made sure every occupied space has supply of outdoor air (mechanical system or operable windows).				
4d.	Ensured that supply and return vents are open and unblocke NOTE: If outlets have been blocked intentionally to correct drafts or discomfort, investigate and correct the cause of the discomfort and reopen the vents.				
4e.	Modified the HVAC system to supply outside air to areas without an outdoor air supply.				
4f.	Modified existing HVAC systems to incorporate any room or zone layout and population changes.				
4g.	Moved all barriers (for example, room dividers, large free-standing blackboards or displays, bookshelves) that could block movement of air in the room, especially those blocking air vents.				
4h.	Ensured that unit ventilators are quiet enough to accommodate classroom activities.				
4i.	Ensured that classrooms are free of uncomfortable drafts produced by air from supply terminals.				
	Activity 18: Pressurization in Buildings				
	NOTE: To prevent infiltration of outdoor pollutants, the ventilation system is designed to maintain positive pressurization in the building. Therefore, ensure that the system, including any exhaust fans, is operating on the "occupied" cycle when doing this activity.				
4j.	Ensured that air flows out of the building (using chemical smoke) throug windows, doors, or other cracks and holes in exterior wall (for example, floor joints, pipe openings).				
5	**EXHAUST SYSTEMS**				
	Activity 19: Exhaust Fan Operation				
5a.	Checked (using chemical smoke) that air flows into exhaust fan grille(s) If fans are running but air is not flowing toward the exhaust intake, check for the following: • *Inoperable dampers* • *Obstructed, leaky, or disconnected ductwork* • *Undersized or improperly installed fan*				
	Activity 20: Exhaust Airflow				
	NOTE: Prevent migration of indoor contaminants from areas such as bathrooms, kitchens, and labs by keeping them under negative pressure (as compared to surrounding spaces).				
5b.	Checked (using chemical smoke) that air is drawn into the room from adjacent spaces. airflow high and low in the door opening (see "How to Measure Airflow").				
5c.	Ensured that air is flowing toward the exhaust intake				
	Activity 21: Exhaust Ductwork				
5d.	Checked that the exhaust ductwork downstream of the exhaust fan (which is under positive pressure) is sealed and in good condition.				
6	**QUANTITY OF OUTDOOR AIR**				
	Activity 22: Outdoor Air Measurements and Calculations				
	NOTE: Refer to "How to Measure Airflow" for techniques.				
6a.	Measured the quantity of outdoor air supplied (22a) to each ventilation unit.				
6b.	Calculated the number of occupants served (22b) by the ventilation uni under consideration.				
6c.	Divided outdoor air supply (22a) by the number of occupants (22b) to determine the existing quantity of outdoor air supply per person (22c).				
	Activity 23: Acceptable Levels of Outdoor Air Quantities				
6d.	Compared the existing outdoor air per person (22c) to the recommended levels in Table 1.				
6e.	Corrected problems with ventilation units that supplied inadequate quantities of outdoor air to ensure that outdoor air quantities (22c) meet the recommended levels in Table 1.				
	Fill out maintenance checklist and report deficiencies				