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ABSTRACT

An investigation was initiated concerning the environmental health within the Burlington, Massachusetts public school system to determine what specific environmental hazards were present and determine ways of eliminating them. This report presents 20 case studies that detail the environmental health issues involved, the approaches taken in investigating each problem, observations on conditions contributing to the hazard's development, the actions taken to eliminate the hazard, the lessons learned, and tips and suggestions concerning preventive management. Each case study concludes with advice on resources that can be used to help schools in investigating and eliminating each environmental hazard. Hazards investigated include the following: chemicals; asbestos; indoor air quality; pesticides; radioactive materials; fire prevention; radon; formaldehyde; safety equipment; spill and emergency response planning; underground storage tanks; and discharges to sanitary drains. (GR)

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Chemical Management
Asbestos Management
Indoor Air Quality
Pesticide Usage
Mercury Management
Radioactive Materials
Fire Prevention
Pollution Prevention
Hazardous Waste
Formaldehyde
Radon
Chemical Fume Hoods
Eye Washes
Safety Equipment
Hazards By Department
Emergency Response
Ceramic Kilns
Underground Tanks
Classroom Lasers
Sanitary Drains

EHS PRIMER

A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System.

"Tips, suggestions, and resources for investigating and resolving EHS issues in Schools"

prepared by
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A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Introduction

In 1992, I began an extensive review of environmental, and health and safety (EHS) issues involving the Burlington, Massachusetts public school system. During this evaluation, I have investigated and researched a broad variety of concerns and potential problems outlined in the table of contents. Many of the conditions I encountered represented significant safety hazards or potential environmental problems. While attempting to research and resolve these problems, I also noted a lack of readily available guidance for identifying EHS issues in schools as well as a hesitancy by regulatory agencies to get involved with school issues.

Based on this premise, I intend to report the results of my ongoing evaluation so that it may be used as a guide by parents, staff, and public officials when reviewing EHS issues in their school system. I believe the snapshot provided by this report is consistent to the types and severity of problems that could be found in schools nation wide. I urge all of you to consider the results reported here and to review these issues at your schools. Even though some of the anecdotes I will report may suggest otherwise, our story is a success story in that we have made the effort to identify the concerns and to take action to correct the problems. I hope this study will enable you to do the same.

I plan to provide a general description of the issues I have reviewed. My intent is to provide the layman with an understanding of the issue, potential problems associated with the issue, tips and suggestions for assisting the evaluation, and lessons I have learned. I will also provide information describing some of the resources I have utilized during this effort.

In the event that you need information regarding a topic which has not yet been posted, you may contact me at the Burlington Board of Health.

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Chemical Management and Usage

I. The issue:

Proper chemical management is critical to preventing and/or controlling a variety of Environmental, Health and Safety (EHS) issues within any facility. The first step towards initiating proper chemical management is the creation of an accurate chemical inventory along with a copy of the material safety data sheet (MSDS) for each item listed on the inventory. An MSDS is an informational document prepared by the chemical manufacturer or distributor which describes chemical, environmental, and health and safety information available for a particular compound. Understanding the materials present at the school will enable you to understand the issues associated with these substances. Properly recognizing and controlling the hazards inherent to these materials will enhance your ability to create a safe school with minimal environmental liabilities. Failure to properly manage your materials can create a myriad of difficult and interrelated EHS issues.

II. The approach taken:

My effort began with a request for an accurate chemical inventory from all sections of the school department and a review of their chemical handling practices. This action was prompted by a history of chemical incidents occurring in the high school. In the 1970's, the chairman of the high school science department discarded ammonium phosphide, a water reactive material, via the sanitary sewer which resulted in the destruction of a portion of the sanitary sewer when the material detonated. The indoor air quality of the school was also compromised during this event by the generation of phosgene gas (a basic chemical warfare agent). In 1991, a fire in the facilities maintenance warehouse at the high school became a serious hazardous materials incident when pallets of bleach, ammonia and sulfuric acid based drain cleaner stored adjacent to each other ruptured and created an acid vapor cloud and chlorine and phosgene gas. The total cost of this event was approximately $500,000.

In order to initiate a hazard analysis of the school system, it was imperative to identify the number, type, volume, and location of the hazardous materials present throughout the school system. The preparation of the chemical inventories provided this basic information. Using this information, I was then able to identify and prioritize the hazards present throughout the school system as a means to most effectively respond to the problems detected.

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III. Observations made:

This was a difficult and time consuming task. It took nearly four years to acquire a complete and accurate inventory from all departments within the school system. The staff and administration did not realize initially how decentralized the purchasing, storage and usage of chemicals had become. Chemicals were found to be stored throughout all areas of the high school. The middle school and elementary schools were better able to locate and identify their chemical inventories, but this was primarily due to the reduced size of their inventories and its limited use within certain areas of the school. The presence of the facilities maintenance department, and an active arts and science departments acted to significantly increase the size and scope of the chemical inventory at the high school.

The lack of centralized purchasing and storage hindered the ability of the school department to track and account for the materials in their inventory. In addition, it was impossible for the school system to ensure its compliance with the Massachusetts Right to Know law. This law is similar to the federal Hazard Communication Standard which requires each employer to maintain a chemical inventory and MSDS database as a means to identify chemical hazards in the workplace and to train and inform their staff of these hazards.

Another problem associated with decentralized purchasing was that the school system tended to purchase an excessive amount of chemicals. Frequently, staff members were purchasing materials that were already present somewhere within the school system. This represented an inefficient use of school funds and created additional regulatory requirements and safety hazards as the materials accumulated.

A de-centralized approach to chemical management and accounting also hindered our ability to respond to an accident or to prevent thief or tampering. This problem was noted during the 1991 fire in the facilities maintenance warehouse. Confusion over what materials were present in the warehouse and the inability to locate MSDS's for materials thought to be present created the need for firefighters to conduct an extremely hazardous exploratory entry to determine what materials were involved in the fire. Proper training, equipment and luck prevented this effort from becoming a tragedy. An increasingly important concern is the need to protect your chemical inventory from thief and tampering. Many of the chemicals commonly found in an educational setting could easily be used in a more threatening manner by a prankster. Furthermore, the school department and individual teachers can be subject to civil liability if they are found to be negligent in their storage and control of chemicals. So if, the local juvenile delinquent walks away with a container of sodium you had stored on a shelf in your classroom and injures himself, then the teacher and the school system can be held liable for the injuries and suffering resulting from the thief. This was a major concern in the high school science area where an average of approximately 150 chemical containers were found initially stored in each classroom. These materials were routinely stored on shelves or in unlocked cabinets or drawers.

Another observation noted was that the school system had a policy of accepting chemical donations. Many thought this was prudent due the declining school budget. In actuality, the school became a dumping grounds for local businesses especially those that were terminating operations or re-locating. As a result, the high school science department collected a large volume of chemicals more useful for electroplating than for the teaching of high school chemistry. The facilities maintenance staff also suffered from this policy by collecting a large number of product samples or promotional products. Products found to be ineffective by the maintenance staff were frequently consigned to a corner of the warehouse and forgotten. Over time, this resulted in the accumulation of a large volume of flammable petroleum based cleaning materials.

Finally, no consideration was given during the acquisition process for the eventual need and cost of disposal of chemicals or the health and safety issues associated with the material. Furthermore, little awareness existed of the need to train and advise the staff how to use, store or dispose of the materials. This lapse in oversight and training resulted in the creation of numerous safety hazards associated with improper chemical storage as well as the repeated disposal of hazardous waste via the sanitary sewer.

IV. The problems or concerns noted:

- The lack of knowledge regarding what chemicals we had, what hazards were associated with these materials, and where the material was stored.
- The accessibility of the materials, and the risk of accident or thief this accessibility presented.
- The inherent risk created by the massive volume of chemistry maintained by the school department.
- The potential toxicity, flammability or reactivity of the individual chemicals maintained by the school department.
- The lack of functioning protective equipment, and health and safety practices in the schools.
- The inefficient use of funds created by overstocking materials.
- The staff's limited understanding of the hazards associated with the chemicals.
- The impact of the acceptance of chemical donations by the school department.

V. Actions taken:

High School Science Department

A. EHS evaluation of the chemical inventory.

In 1993, I reviewed chemical inventory maintained by the high school science department for EHS issues. As a result, I determined that 40% of the inventory were human carcinogens, teratogens (capable of causing birth defects), and mutagens (capable of causing genetic damage). I also noted that the chemistry curriculum was heavily involved with the use of organic solvents such as benzene (volatile, flammable and carcinogenic), carbon tetrachloride (volatile and carcinogenic) and carbon disulfide (volatile, flammable, narcotic poison). During my review, I also noted the presence of a number of acutely toxic materials (e.g. cyanide salts and bromine gas), radioactive materials (e.g. thorium nitrate and uranium tetrachloride), and potentially explosive materials (e.g. ethyl ether and cumene). In addition, many of the components of the science department inventory posed lesser hazards due to their individual corrosivity, toxicity or reactivity.

One major problem I noted during this evaluation was that the material safety data sheets (MSDS) provided by firms specializing in supplying chemicals to schools were frequently inadequate in terms of quality and detail. All reviewers should beware of MSDS's that frequently contain omissions within the body of the document or repeatedly list 'not applicable' especially for common materials. I also recommend that you notify your supplier or the federal Occupation Safety and Health Administration if you notice a repeated trend in poor quality or vague MSDS's. Remember depending on your setting, state and/or federal hazard communication requirements specify your responsibility to identify and address the hazards associated with the materials you use. If the manufacturer does not properly identify these concerns, then you may be required to research it more thoroughly. The bottom line is to demand better service and information from your supplier or find a new supplier.

Once the size, scope and location of the chemical inventory had been established, we were now in a position to proceed with addressing the EHS concerns created by the material.

B. Terminated chemical donations.

One of the first steps taken to prevent the continued acquisition of extremely toxic and hazardous materials with limited educational value was to ban the acceptance of chemical donations. A more than twenty year practice of accepting chemical donations had resulted in the accumulation of a large volume of material better suited for metal plating and the manufacture of electronics than the instruction of high school chemistry. In an effort to enhance their inventory without impacting their budget, the science department had willingly accepted material from local industry. The staff accepted the good with the bad, frequently without reviewing what exactly they had received. The net result was the creation of a huge and extremely hazardous chemical inventory. The size and scope of this inventory also made it impossible for the science department to comply with the Massachusetts worker right to know requirements.

The termination of this practice signaled the first effort to control the influx of new materials. This was an extremely important step because the cost of chemical disposal alone is frequently two to three times the cost of purchasing the materials. The possession of certain chemicals may also trigger additional regulatory requirements or unique storage issues. I

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encourage all school systems to adopt a similar policy to prevent your schools from becoming a chemical disposal option for local industry and to prevent a right to know compliance nightmare.

C. Established a centralized chemical storage policy.

After identifying the major hazards associated with the chemical inventory, our next step was to implement a centralized chemical storage policy in order to enhance chemical control and accountability, and to remove the chemical hazards from the classroom. Even though a centrally located, secured and ventilated chemical storage room equipped with a carbon dioxide fire suppression system had been constructed within the science area, the staff had opted to store the bulk of their inventory in their classrooms for convenience. During a comprehensive inspection, we found unsecured materials stored in the closets, cabinets, desks, and on shelves in each classroom and preparation area. The majority of the materials were readily accessible. In most cases, these materials were stored in an random manner.

The historic chemical storage practices of the department posed a major obstacle to our effort to comply with state right to know requirements and to prevent the theft of materials. This method of storage also increased the likelihood of a serious hazardous materials incident occurring in the classroom due to the storage of chemicals in areas not designed or equipped to provide additional protection in the event of a fire. This risk was compounded further by the common practice of the storing the materials without regard to chemical compatibility or reactivity.

We resolved these problems by re-locating the entire inventory to the chemical storage room originally designed and constructed for this purpose. During this process, we used the chemical storage protocol outlined by Flinn Scientific as our guide to ensure that the materials were stored properly with regard to chemical compatibility and reactivity concerns. This task allowed us to immediately identify the true size of the chemical inventory and prompted a major disposal effort when we realized our inventory vastly exceeded our storage capacity.

D. Established a chemical disposal policy and conducted a massive chemical removal.

After reviewing the hazards associated with inventory, and the laboratory facilities at the school as well as the history of accidents and near misses at the school, the Burlington Board of Health ordered the science department to dispose of all confirmed carcinogens, teratogens, mutagens and acutely toxic materials. The Board of Health also recommended that the department dispose of all materials no longer used by the staff, contaminated or degraded materials, and where possible to reduce the volume of overstocked items. As a result, 65 drums and containers of hazardous waste were disposed of during a one time clean out conducted in September 1993. The following is a sampling of materials disposed of at this time:

- 0.5 lbs of chloral hydrate, a controlled barbiturate
- 3.5 lbs of unsealed radioactive materials including thorium nitrate and uranium tetrachloride
- 42 one liter glass cylinders containing bromine gas
- 12 containers of various potentially explosive peroxide forming materials (e.g. ethyl ether, dioxane, formic acid, cumene, furan, tetrahydrofuran, sodium peroxide, barium peroxide, and potassium metal)
- 7 lbs of water reactive metals: sodium, lithium and potassium
- 5.5 lbs of cyanide salts
- gallons of benzene, carbon tetrachloride, chloroform, aniline, and formaldehyde
- 10 lbs of elemental mercury, and 3 lbs of mercuric compounds
- 5 lbs of explosive white phosphorus
- 5 lbs of potentially explosive potassium chlorate
- 1 lb of polychlorinated biphenyl's (PCB's)
- 3 lbs of powdered cadmium
- 1 lb of powdered arsenic
- 2 lbs of powdered antimony
- 1 gallon of o-toluidine
- approximately 100 lbs of potentially explosive oxidizers

At this time, we also adopted a five year review plan for each chemical. Using a five color coding system, we labeled all materials to indicate their approximate date of purchase. The color coding system is designed to quickly identify the date of purchase and age of each container in the inventory. It is now the responsibility of the chairman of the science department to review each chemical container on the fifth year of its purchase to determine if the material should be retained or discarded. This evaluation is based on the EHS issues associated with the material, whether the material is still being used by the department, and the integrity or quality of the material. We hope that this approach will aid our efforts to prevent the chemical overstocking observed in the past.

E. Provided staff with training.

Another key component to addressing our chemical hygiene problems was to provide the staff with basic training in chemical hygiene and EHS awareness. A main component of this effort was to review how to read and understand an MSDS as well as learning to interpret the quality of an MSDS. This was extremely critical because I found that the majority of the staff had no formal training or knowledge in this area. This was compounded by the staff reliance on textbooks or chemical supply catalogs which did not mention EHS issues or provided erroneous recommendations. Habit was also a significant barrier to change and improvement. Much of the staff was resistant to change even after the health and safety issues of certain activities had been reviewed in detail. As a result, I have modified the training regimen to include a discussion of the types of liability associated with accidents involving chemical usage in schools.

F. Established centralized chemical purchasing.

We also established a centralized chemical purchasing system where the chairman of the science department became responsible for reviewing chemical purchases. The intent of this plan is to ensure that chemicals are reviewed for the following parameters prior to purchasing: 1) hazards associated with the material, 2) potential impact on air quality, 3) generation of hazardous waste, and 4) the availability of less toxic alternatives. This initiative is designed to prevent over stocking and the acquisition of inappropriate materials. The effort has also enhanced our ability to maintain an accurate chemical inventory and MSDS database as required by the Massachusetts Right to Know law.

G. Banned the disposal of regulated chemicals via the sanitary sewer.

During routine inspections, I noted that the staff repeatedly disposed of state and federally regulated hazardous waste via the sanitary sewer. Our first attempt to address this problem was to advise and train the staff with regard to the discharge requirements established by the local sewer authority. This effort met with limited success. As a result, the Board of Health adopted the position that it would issue citations and fines to individual teachers if they were caught discharging materials. The publicity associated with this position and the concern over incurring a $200 fine provided the motivation to reduce the discharge of hazardous waste via the sanitary sewer.

H. Established a hazardous waste management plan.

A hazardous waste management plan was also developed as a means to promote the identification, collection and proper disposal of all hazardous waste generated by the staff. The staff were instructed to review their procedures to determine what wastes were generated and how these materials had to be managed (acceptable for disposal via the sanitary sewer versus manifested disposal as a hazardous waste). In addition, a satellite hazardous waste storage area was also established in an isolated and secured portion of the science area. The staff was also instructed to ensure that all waste containers were to be kept sealed and labeled at all times. Depending upon the rate of generation, this waste material is re-located to the school's central hazardous waste storage area on a bi-weekly or monthly basis pending proper disposal.

I. Assessed classroom setting and availability of protective equipment.

Our safety evaluation also included a review of how the classrooms were equipped and the safety practices utilized by the staff. During this assessment, I found that the majority of the classrooms were not equipped with emergency eyewash units or chemical fume hoods. In addition, I also noted that the units available appeared to be either unused or unmaintained. We also noted a significant shortage in terms of safety glasses, protective gloves and aprons. During training sessions, we reviewed the need to use and maintain various safety equipment. We also reminded the staff of the Massachusetts state law requiring the use of protective eyewear when chemicals are used in an educational setting. As a result of this review, new safety supplies were purchased so that each classroom was equipped with an emergency eyewash and an adequate amount of protective equipment. Unfortunately, the staff use of safety equipment continues to be spotty and not fully compliant with state requirements.

J. Investigation of the chemical fume hoods.

During my survey, I noted that the staff rarely used the chemical fume hoods in the science area. Upon closer examination, it became obvious that many of the units were in a state of disrepair. Our efforts to investigate and repair the fume hoods provides evidence of the need to hire a trained and competent professional to evaluate and maintain these units. During this review, we initially found that the exhaust fan had been removed from the majority of the units, presumably for energy savings. The remaining units were found to be equipped with improperly sized and balanced intake and exhaust fans. In addition, when tested with smoke, approximately half the units or associated ductwork were found to leak contaminants into the building. A final and fatal flaw was also detected for all chemical fume hoods. All hoods were found to be constructed with the exhaust located adjacent to the intake for each unit, consequently even if functional, the hoods could not remove contaminants from the classrooms and laboratories without re-introducing the materials to the building.

We have worked with an architect and certified industrial hygienist to correct and resolve these deficiencies. We have also provided the staff with additional training regarding the safe and proper use of the hoods. In addition, each hood has been labeled to indicate the safe work area within the hood as well as the proper sash height for safe operation.

An inexpensive tip for screening the function of a chemical fume hood is to test the unit using a 60 to 90 colored smoke bomb. If the unit is functioning properly it should easily evacuate the smoke to the outdoors. Common problems you may observe would be the failure of the smoke to exit the unit, smoke leaking from the hood or ductwork, and smoke re-entering the intake or the building ventilation system. One word of caution would be to coordinate all smoke tests with your fire department to ensure that all area smoke detectors have been disabled prior to testing. This graphic and inexpensive demonstration can be a useful indicator of whether a serious problem may exist. This test does not replace the need to have the units tested and re-calibrated on annual basis by a competent professional. Also, all units found to display improper air flow should be removed from service until inspected and repaired.

K. Investigation of curriculum changes as a means to promote pollution prevention and improve air quality and classroom safety.

In addition to the actions noted, the science department has placed emphasis on researching and adopting a less toxic curriculum as a means to promote pollution prevention, and health and safety. This effort has focused on the elimination of the most toxic reagents as well as the implementation of microscale experiments as a means to reduce the volume of materials used or generated. This process has been supported by the adoption of a chemical use review policy which requires the staff to review each procedure with regard to: a) hazards associated with the activity, b) potential impact of air quality, c) protective equipment required, and d) the generation of hazardous waste. The School Committee has adopted a formal review policy which prohibits student use of any materials or the generation of any reaction byproducts which have a National Fire Protection Association (NFPA) hazard ranking of 4 or carcinogens. (The NFPA is a technical advisory group conducting research for fire prevention and hazardous materials mitigation. The NFPA has established a 0 to 4 hazard ranking scale for chemicals based on the flammability, reactivity and the health hazards associated with material. The level of hazard increases as you move from 0 (no hazard) to 4 (most severe hazard).) In addition, each teacher is now required to justify the use or generation of any material that may generate a substance with an NFPA ranking of 3.

High School Art Department

A. Reviewed issues associated with arts curriculum and chemical inventory.

A review of the art department indicated that the program consisted of the following activities: photography, computer graphics, painting, and ceramics.

Photography: Standard fixers and developers were found to be utilized by the photography lab. In addition, the use of protective equipment was observed to be a common practice in this area. The primary concerns for this area were proper ventilation and proper waste management. The common use of chemicals in a photolab that was not originally designed for this purpose has raised a number of concerns regarding proper ventilation of this space. These issues will be discussed in detailed in the section related to indoor air quality. The waste generated in the photography lab is containerized for off site disposal. This appears to be the wiser practice because there is no encouragement to the staff or students to discharge the materials via the sanitary drains as would be the case if a neutralization system or silver recovery system were in place. By using off site disposal, we also avoid the need for acquiring a discharge permit from the local sewer authority and conducting compliance testing routinely required by discharge permits. The wastes are now managed as part of the hazardous waste management program adopted by the school system.

Computer graphics: The major hazards associated with the computer graphics laboratory are associated with electrical safety and potential impact on indoor air quality. The computer graphics lab has grown and expanded as society's use of the computer has grown. The concern for electrical safety is based on the constantly increasing accumulation and use of electrical equipment in an area not originally designed for this purpose. The presence of a large number of power cords and cables poses a serious fall hazard. There also exists the risk of toppling equipment should the cords or cables become caught on a moving object. The most serious electrical concern is the risk of creating a fire hazard by over loading an electrical circuit. These conditions are most appropriately reviewed by a licensed electrician.

Indoor air quality concerns also existed in the computer graphics lab. The accumulation and use of a large volume of electronic equipment in an area not originally designed for this activity resulted in degradation of the air quality in this area. We had three areas of concern: the generation of volatile organic contaminants evolving from the toners and inks used, the generation of ozone by the equipment, and the decline in the humidity in this area. The standardization of the toner and ink chemistry limits our ability to reduce the generation of the emissions from these materials. As a result, we hope to reduce the potential impact of these materials by increasing the rate of fresh air exchange in this area as a means to dilute and remove the contaminants. On a number of occasions, I have monitored the computer lab and measured temperatures ranging between 85 to 90 degrees Fahrenheit with humidity at 15% to 25%. The heat given off by the equipment combined with inadequate air exchange acts to heat the room and lower the humidity. As a result, this promotes the generation of hazardous ozone. Ozone is a significant respiratory irritant. The decline in humidity also increases the generation of static electricity in the area which can be detrimental to the equipment and annoying to the occupants. Also, a lower humidity level tends to cause soft tissues such as mucous membranes and the eyes to dry and become irritated. The generation of harmful ozone can be mitigated by lowering the temperature and increasing the humidity in the laboratory. This approach will also improve the comfort level for the occupants. We hope that by lowering the room temperature, increasing the ventilation rate, and increasing the humidity level that we will be able to address the three air quality concerns we have identified.

Painting: The bulk of the painting done by the department involves the use of water based materials, however, acrylics and aerosols are used. The only concern noted involving the use of water based materials is that some of these products have been found to contain heavy metals. Consumption or accidental ingestion of these materials is not consider a high risk by high school students but may be a greater concern for younger students. I also noted that it is difficult to review the health and safety of these products because many of the MSDS's generated for these products are frequently of low quality and lacking in detail. When ordering supplies, you should confirm that the product complies with ASTM D4236, an art safety standard adopted by the federal Consumer Product Safety Council. In order to bear this seal, the product must undergo toxicity testing to confirm that it is safe for use by children. A sampling of this labeling can be found on most Crayola® products.

The use of acrylics and aerosols occasionally has resulted in the degradation of the air quality of the art studio and adjacent classrooms. We have provided the staff with right to know training and discussed the need to locate more benign products or to use the materials in a better ventilated area. This approach has met with limited success. In addition, we are also planning repairs and modifications to the existing ventilation system.

Ceramics: The high school has a very active ceramics program. As part of this curriculum, the students have been instructed in the art of mixing different types of clays and glazes using dry powdered components. This practice has created numerous significant respiratory hazards.

The most significant hazard is the generation of free silica dust. Free silica is a chemical cousin to asbestos with regard to physical qualities and health and safety effects. A review of the clay powders used by the department indicated that the products in their inventory typically contained between 20% to 90% free silica, and in some cases asbestos. The storage, handling and mixing of these powdered materials resulted in the airborne release of large quantities of free silica which has contaminated the ceramics studio, the ventilation system in the ceramics studio and adjacent class rooms. By converting to the use of pre-mixed wetted clays, we were able to significantly reduce the generation of free silica in the ceramics studio. Unfortunately, free silica will continue to be produced when ever a dry piece of ceramics is sanded or sculpted. The school department has attempted to address this hazard by conducting these activities in a chemical fume hood. The size of the free silica particles decreases the likelihood that this approach will be effective at controlling or removing the free silica from the classroom. Aside from eliminating these activities or conducting them outdoors, the most effective means for controlling the free silica hazard is to implement a rigorous daily cleaning regimen which involves the damp mopping or HEPA vacuuming of all surfaces in the work area. A HEPA vacuum is a high efficiency particulate vacuum used to remove extremely small particles while also filtering its exhaust so that fine materials are not released. Warning - Do not use standard household type vacuums to collect free silica because these units are not capable of collecting and retaining the silica and will act to transport the problem throughout the building.

The mixing of glazes and englobes also resulted in exposing students to a number of severe respiratory hazards associated with the use of toxic heavy metals. The students and staff used a variety of powdered metals (e.g. chromium, cobalt, nickel, and titanium) to prepare various colorants. These actions exposed the user to a variety of potential carcinogens, mutagens, and teratogens. This activity also resulted in the release of the materials to the classroom and the ventilation system. We resolved this issue by training and informing the staff and administration of the hazards created by this activity and by using pre-mixed manufactured glazes and englobes with limited heavy metal content.

In addition, all extremely hazardous metallic powders and dry powder clays have been removed from use in the classroom and disposed of in accordance to state and federal requirements. During this effort, we disposed of several hundred pounds of clay powders and approximately

100 pounds of various heavy metal powders.

B. Inspection of the kilns used by the ceramics program.

The high school art department maintains two kilns which area located in an interior room lacking a window. Proper venting of the kilns is critical due to the degradation of indoor air quality caused by the generation of carbon monoxide, volatile organic compounds, and metallic vapors. Initially, the kiln room was vented to the outdoors via a manually operated ceiling mounted exhaust fan which was ducted thirty feet to the outdoors. The discharge for this ductwork was 10 feet below the roof line within a partially enclosed area and adjacent to the discharge was an inoperative louver fan for the ceramics studio. The following problems existed with this design. First, the kiln exhaust was not ducted to the exhaust fan but allowed to passively be drawn to the fan. This approach allowed the kiln emissions to escape the kiln room via two door ways or via the building heating and ventilation system which also serviced the kiln room. In addition, the operation of the exhaust fan was manually operated by the staff and students and due to its noisy operation most individuals preferred not to use the fan. Furthermore, it was questionable that the exhaust fan was capable of transporting captured emissions the required thirty feet and discharging the material via the louvered opening. Finally, it is likely that a portion of those materials that were discharged by the exhaust system probably re-entered the building via the louvered fan located adjacent to the kiln exhaust discharge.

We addressed these problems by installing bottom mounted exhaust fans on both kilns. The kiln exhausts were also ducted directly to the existing exhaust system which was equipped with two quieter booster fans. The exhaust system was also modified to discharge above the roof line. The exhaust system has also been hard wired to operate when the kilns are in operation.

C. Improved chemical storage to prevent tampering or thief.

Efforts have been initiated within the art department to improve chemical management and control. Several flammable storage cabinets have been purchased and the bulk of the chemical inventory has been moved from classrooms to secured storage closets and cabinets.

D. Established a chemical use review policy.

A chemical use review policy has been adopted which requires the art department chairman to review the materials and procedures involving the use of chemicals for the following parameters: a) health and safety concerns, b) impact on air quality c) need for protective equipment, and d) the generation of hazardous waste. The materials used by the art department are also subject to the review and consideration of the School Chemical Oversight Committee.

E. Established a hazardous waste management plan.

All hazardous wastes generated by the art department are now forwarded to the care of the facilities maintenance staff which manages the overall hazardous waste management plan adopted for the school. A satellite hazardous waste storage area has been established in the photolab for the waste fixer and developer generated in this area. All other waste is transferred to the central hazardous waste storage area as it is generated.

F. Provided staff with training.

The staff have been trained with regard to worker right to know, basic chemical hygiene, and new chemical review and handling procedures. The staff have also been advised to re-examine their procedures involving the use of chemicals and to seek less toxic alternatives. The increased training and awareness has achieved limited success in promoting procedure changes and chemical substitutions. A resistance to change has been noted in this area. In addition, the use of chemicals by the staff continues to occasionally impact the air quality at the school.

Facilities Maintenance

A. Reviewed issues associated with inventory.

A review of the chemical inventory maintained by the facilities maintenance staff determined that the department did not maintain an accounting of the materials it possessed. In addition, the department tended to acquire small batches of related products with similar uses while rarely consuming all the materials. As a result, the department was overstocked and not in compliance with the Massachusetts Right to Know record keeping requirements. Furthermore, their approach to chemical management had resulted also in the accumulation of a large volume of flammable petroleum based cleaning products. Another concern noted was that many materials were stored in the warehouse without regard to chemical compatibility and therefore posed a significant risk to local emergency responders.

B. Improved oversight of chemical acquisition.

As the result of improved training and guidance, the facilities maintenance department has reduced its chemical inventory and virtually eliminated its use of petroleum based products. This reduction was achieved by implementing chemical purchasing controls, consumption of useful materials, and the disposal of obsolete or degraded materials. A one time chemical clean out was also conducted to remove major fire hazards and prohibited items. During this effort we disposed of 50 pounds of various pesticides and over 350 gallons of methanol duplicating fluid. The department has also decreased its willingness to accept free samples or test quantities from suppliers.

C. Modified chemical storage with regard to chemical compatibility.

The staff have been trained and advised in the need to store materials with regard to chemical compatibility. The department is also exploring the suggestion of constructing or designating storage areas within the warehouse which are based on general chemical classes and compatibilities. Unfortunately, the transient nature of the materials moving through the high school warehouse area and low level of importance given this task by the staff has made this a difficult issue to resolve.

D. Established a chemical use review policy.

All materials utilized by the facilities maintenance department are subject to the chemical use review policies adopted for the school system. It is now the responsibility of the director of the facilities maintenance department in addition to the School Chemical Oversight Committee to review and monitor chemical use by the department for the following parameters: a) health and safety hazards, b) potential impact on air quality, c) need for protective equipment, and d) the generation of hazardous waste.

E. Established a hazardous waste management plan.

The facilities maintenance department fulfills a critical function in supervising the implementation of the school department hazardous waste management plan. The department is responsible for maintaining the central hazardous waste storage area and for re-locating departmental wastes to this location. Several staff members have been provided with 8 hour First Responder training as defined in 29 CFR 1910.120, the Occupational Safety and Health Administration HAZWOPER Standard, as well as additional training to ensure the proper management of hazardous waste. In addition, the disposal of all hazardous waste generated by the School Department is now carried out in conjunction with the regular municipal hazardous waste disposal program at programmed intervals. It is the intent of the town to insure that the school system maintains the generator status of a very small quantity generator (or conditionally exempt small quantity generator) at all times. The incorporation of the school's hazardous waste disposal activities into the existing town program has significantly enhanced our ability to promote the safe and proper disposal of hazardous materials.

Middle and elementary schools.

A. Reviewed hazards associated with chemical inventories.

I conducted a chemical hygiene review of the inventories maintained by the middle and elementary schools. Significantly fewer hazards were found at these schools primarily due to the decreased size of the chemical inventories present. The chemical hazards present at the middle school were associated with the chemical inventories maintained by the science and arts departments. Fortunately, the smaller inventory combined with the reliance on more benign household products for chemical experiments and demonstration lowered the risk factor associated with the inventory. In addition, the arts department also maintained only a small chemical

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inventory. Fortunately, the art instructors had already converted the bulk of their inventory to low toxicity materials.

The chemical hazards present at the elementary schools were even less due to the limited amount of chemicals present. Art supplies were the primary chemical components present at the elementary schools. Again, the staff had already recognized the potential hazards and converted their materials to approved low toxicity materials.

Cleaning and maintenance supplies also represented a potential hazard at these schools. These hazards were controlled and reduced by limiting and securing the quantities stored on site and by consolidating the bulk storage of these materials at the high school warehouse.

A significant hazard that was noted at the middle and elementary schools was the presence of poorly identified hazardous materials in pre-packaged instructional kits designed for the non-scientist. Concentrated acids, poisons, and carcinogens were found in educational kits designed for grade levels K through 8. Often times chemicals solutions were simply labeled: "Solution A, Do not consume, Poison." Frequently, these kits provided only a generalized description of the safety hazards associated with the materials contained in the kit. This lack of information could seriously hinder medical aid and emergency response in the event of an accident. Also, the merit for using some of these materials at the intended age level is questionable. I urge all instructors to carefully review the contents of these kits and the hazards associated with the test materials before purchasing and using the kits.

B. Assessed classroom setting and availability of safety equipment.

Our safety evaluation also included a review of the how the classrooms were equipped and the safety practices utilized by the staff. During this assessment, I found that the majority of the classrooms were not equipped with emergency eyewash units or chemical fume hoods. We also noted a significant shortage in terms of safety glasses, protective gloves and aprons. During training sessions, we reviewed the need to use and maintain various safety equipment. We also reminded the staff of the Massachusetts state law requiring the use of protective eyewear when chemicals are used in an educational setting. As a result of this review, new safety supplies were purchased so that each classroom was equipped with an emergency eyewash and an adequate amount of protective equipment. Based on the type of experimentation conducted by the staff, it was determined that the potential impact on air quality was minimal and as a result the widespread availability of a chemical fume hood was not considered critical at the middle school level at this time.

C. Established a chemical use review policy.

All materials utilized within the middle and elementary schools are subject to the chemical use review policies adopted for the school system. It is now the responsibility of the instructional team leaders and the School Chemical

Oversight Committee to review and monitor chemical use by these staff members for the following parameters: a) health and safety hazards, b) potential impact on air quality, c) need for protective equipment, and d) the generation of hazardous waste.

D. Reviewed and improved chemical storage.

In general, the art supplies were found to be stored in one or two classrooms at each school. The major modification to the storage of these materials was to re-located these materials to lockable cabinets or closets and to label these areas for emergency responders. The individual classrooms at the elementary schools were inspected for educational kits containing chemistry. The bulk of this chemistry was disposed of as obsolete materials via the municipal hazardous waste disposal program. The chemical inventory maintained by the middle school science department was removed from the classrooms and re-located to a central secured storage closet as a means to enhance security and control.

E. Other hazard noted - kilns.

While reviewing the art supplies in the middle and elementary school, I noted that all the kilns located at these schools vented directly into the schools. As a result, carbon monoxide, volatile organic materials and other emissions were being released into the schools whenever the units were fired. This resulted in a degradation of the indoor air quality of these schools. This problem was addressed by installing the appropriate ductwork and exhaust fans to vent the units outside.

Systemwide

In addition to establishing departmental chemical review responsibilities, the School Committee also created a Chemical Oversight Committee. The intent of this was that the Oversight Committee would assist with the departmental reviews as needed and to monitor the quality of these reviews. This group also is available to provide technical assistance and guidance to school personnel.

Lessons learned:

The following is a summary of significant lessons I noted during the investigation of environmental, and health and safety issues involving the Burlington public school system.

1. Be persistent: Change does not come easily and as in our case if motivation for the changes comes from outside the school system it is likely that you will encounter greater resistance to change.

2. Inspect and verify: Two heads are better than one. Someone must review your actions in order to verify the accuracy and completeness of the task. In addition, the reviewer may have a different perspective and may note something that was originally overlooked.

3. Provide staff with training and guidance: The staff must be provided with training and guidance to understand the significance of EHS issues in the classroom and the potential hazards and liability associated with these concerns. Training should be conducted during the initial phase of investigating EHS issues so that the staff can participate with the investigation and resolution. Annual refresher training should also be initiated.

4. Establish staff accountability for chemical use and misuse: The school system should adopt formal policies requiring the staff to review chemicals and experimental procedures for EHS concerns. The school system should also adopt chemical storage requirements as a means to control access and prevent the theft of materials. This system will not prevent all accidents from occurring but it does provide accountability for overlooking obvious hazards and sloppy chemical management.

5. Review the text and reference materials used by the staff for instructions regarding EHS issues: When I reviewed the text and reference materials used by the staff, I found that most material prepared prior to 1985 did not provide a discussion of the EHS issues associated with chemical procedures. I also noted that the staff relied heavily on reference materials and chemical disposal guidance provided by their chemical supplier. I found the bulk of this information to be insufficient and frequently illegal. I recommend that every school system acquire text books and reference materials which describe proper chemical handling and disposal methods. You should also contact federal, state and local environmental, and health and safety agencies to determine if any more specific requirements exist for your area. In general, I would hesitate to dispose of any chemistry via a sanitary drain or to try to chemically neutralize any material without first consulting your regional agencies.

Tips and suggestions:

1. Use a smoke bomb to test mechanical ventilation: This simple and inexpensive test can provide you with a quick and easy qualitative assessment of the function of a chemical fume hood or kiln exhaust. The use of brightly colored smoke will enable you to easily determine if exhaust may be escaping from the test unit, the ductwork associated with the unit, or if the exhaust is re-entering other portions of your ventilation system. This is only a quick and dirty analysis designed to check for major problems. This approach does not replace the need to have a trained professional inspect, maintain and calibrate these units.

2. Seek assistance from local resources: We are all in this together. Tap into the assistance that is available from federal, state and local environmental, and health and safety agencies. Do not overlook local residents, corporations, and medical facilities. These groups have a vested interest as parents and tax payers, and are frequently willing to provide technical expertise and assistance.

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3. Consider chemical compatibility when storing your inventory: Do not store your materials in alphabetical order but by chemical hazard classification. Failure to consider chemical compatibility prior to storage could cause reactive materials to be stored together and result in a small fire becoming a catastrophic hazardous materials incident. Your emergency responders will appreciate your efforts. For your reference Flinn Scientific Incorporated of Batavia, Illinois (1-800-452-1261) provides a chemical storage plan based on chemical compatibility in their supply catalog. ***(Please note: EPA does not endorse specific vendors. This information is provided by the Burlington Board of Health as one potential source of assistance.)***

4. Adopt a microscale curriculum: The microscale concept is to alter your experimental procedures so that you use approximately 1/10th of the amounts originally planned for by the author. Conversion to microscale may require the purchase of new glassware, however the benefits include the development of better techniques by the staff and students, decreased chemical usage, lowered exposure to hazardous materials, and a reduction in hazardous waste generated. For more information describing microscale contact: Dr. Mono M. Singh, Director, The National Microscale Chemistry Center, 315 Turnpike Street, Merrimack College, North Andover, Massachusetts 01845, Telephone: (978)837-5137, Fax: (978)837-5017, or via e-mail at 'msingh@merrimack.edu'.

5. Adopt a less toxic curriculum: As a I mentioned in item 5 of the lessons learned, you must review the curriculum to determine if safer, less toxic alternatives can be implemented. I have found that frequently many options exist for providing the same educational experience, however some motivation must be provided to prompt the search for a safe alternative. I recommend that you consult your state pollution prevention agencies for assistance. In Massachusetts, we are fortunate to have the Office of Technical Assistance and Surface Cleaning Laboratory. These agencies provide free, non-regulatory pollution prevention assistance to the public. In Burlington, we have also adopted a number of procedures presented in "40 Low-waste, Low Risk Chemistry Labs", by David Dugan, published by J. Weston Walch of Portland, Maine (207-772-2846). We have found this text to provide a more detailed discussion of EHS issues associated with the procedure combined with the use of less toxic alternatives than normally found in most chemistry text books.

6. Hazardous chemicals: During my travels, I have encountered several lists of high risk science chemicals. The following is a compilation of these lists. This list is illustrative and is not an exhaustive list of potentially hazardous chemicals. Each chemical requires thorough risk evaluation by a qualified professional prior to use.

	Explosive/fire hazard	
potassium chlorate	benzoyl peroxide	carbon disulfide
collodion	cyclohexene	1,4-dioxane
ethyl ether	isopropyl ether	tetrahydrofuran
styrene	phosphorus pentoxide	yellow/white phosphorus magnesium powder
formic acid (aged)	anhydrous aluminum chloride	lauryl peroxide
potassium metal	nitroglycerin	nitrogen trioxide
2,4-dinitrophenol	2,4-dinitrophenolhydrazine	perchloric acid
low flash point solvents	aged & excessive oxidizers	thermit
picric acid	leaking gas cylinders	sodium metal
lithium metal	divinyl acetylene	vinylidene chloride
sodium amide	acetalmethyl i-butyl ketone	ethylene glycol
dimethyl ether (glyme)	vinyl ethers	dicyclopentadiene
diacetylene	methyl acetylene	cumene
tetrahydronaphthalene	methylcyclopentane	t-butyl alcohol
butadiene	tetrafluoroethylene	vinyl acetylene
vinyl acetate	vinyl chloride	vinyl pyridine
chlorobutadiene/chloroprene	indene	furan
all peroxides	all isocyanates	picramide
isoprene	all aliphatic ethers	aminoguanidine nitrate
ammonium dichromate	calcium carbide	cylcohexane
methyl ethyl ketone	methyl methacrylate	petroleum ether
phosphorus, red	potassium chlorate	sodium azide
sodium sulfide	toluene	xylenes

	Reactives	
bromine	hydrofluoric acid	titanium tetrachloride
osmium compounds	aluminum chloride	antimony trichloride
lead nitrate	lithium, metal	lithium chloride
potassium, metal	potassium chlorate	sodium, metal
potassium permanganate	sodium chlorate	sodium chromate tetrahydrate
sodium dichromate	sodium nitrite	sodium sulfide
stannic chloride	nitric acid	sulfuric acid
hydrochloric acid	uranyl nitrate	

	Toxic	
ammonium metavanadate	caffeine	colchicine
lead compounds	mercury	mercury compounds
nicotine	sodium azide	cyanide salts
thioacetamide	thiourea	brucine sulfate
unsealed radioactive sources	o-toluidine	ammonium oxalate
antimony	antimony trioxide	arsenic trichloride
arsenic trioxide	barium chloride	calcium fluoride
chloretone	chloroform	chromium oxide
chromium potassium sulfate	cobalt nitrate hexahydrate	cylcohexane
p-Dichlorobenzene	dichloromethane	lead arsenate
lead carbonate	lead chloride	lead nitrate
lithium nitrate	methylene chloride	nickel powder
selenium	silver nitrate	sodium arsenate, dibasic
sodium fluoride	sodium oxalate	stannic chloride
uranyl acetate	uranyl nitrate	wood's metal (lead alloy)
thorium nitrate	uranium tetrachloride	

	Carcinogens	
arsenic	carbon tetrachloride	benzene
formaldehyde	chloroform	aniline
lead acetate	acetamide	acrylamide
antimony trioxide	arsenic and compounds	beryllium & compounds
cadmium & compounds	calcium chromate	carbon black
chromium & compounds	cobalt & oxides	lead phosphate
mercury alkyl compounds	methyl chloride	nickel & soluble compounds
thorium & compounds	titanium dioxide	o-tolidine
o-toluidine	trypan blue	acrylonitrile
ammonium chromate	ammonium dichromate	aniline hydrochloride
ethylene dichloride	hematoxylin	potassium chromate
sodium chromate tetrahydrate	sodium dichromate	sudan IV
talc	tannic acid	thioacetamide

7. Encourage chemical suppliers to post MSDS's on internet: In order to enhance your accessibility to chemical information, I urge you to encourage your suppliers to post their MSDS databases on the internet. A number of colleges and universities have begun this effort. Your support and assistance will further the cause and enhance the ability of emergency responders and medical personnel to respond to a chemical accident. Under the heading of internet resources, I have listed several organizations that

maintain MSDS databases on the internet. Most of these groups are willing to add new information to their existing database. I encourage you to support their efforts.

Resources

1. Internet resources: The following is a compilation of useful internet addresses that may assist you when researching EHS or regulatory issues. Please note that several of these sites maintain accessible MSDS databases for your use. These providers will also accept any new MSDS's that you or your supplier may be able to provide.

Address: EXIT EPA	**Site Description:**
http://www.osha.gov/oshasoft	OSHA regulations & software(fire, asbestos)
http://www.turi.org	Mass Toxic Use Reduction Institute
http://www.cleaning.org	Mass Surface Cleaning Lab
http://www.cdc.gov	NIOSH info & toxicological registry
http://www.access.gpo.gov	federal government printing office
http://www.acs.org	American Chemical Society
http://www.instantref.com/tox-chem.htm	chemical management info
http://chemfinder.camsoft.com	searchable chemical database
http://ecologia.nier.org	35 environmental databases
http://es.epa.gov	pollution prevention info
http://www.lib.uchicago.edu/~atbrooks/safety	chemical safety collection
http://www.aiha.org	American Industrial Hygiene Association
http://turva.me.tut.fi/~oshweb	index of health & safety resources on net
http://www.artswire.org	Center for Safety in the Arts
http://www.iarc.fr	International Cancer Registry
http://www.ABIH.org	American Board of Industrial Hygiene
http://www.pdc.cornell.edu	large MSDS database
http://www.mrg.ab.ca/christie/safe1.htm	searchable safety database
http://www.purdue.edu/REM	chemical hygiene plan
http://www.chem.uky.edu/resources/msds.html	MSDS database
http://www.siri.org	EHS bonanza, MSDS's & much more
http://www.princeton.edu/~ehs/h&sguide/	safety auditing guidance
http://www.baqa.org	Building air quality alliance

2. Reference books: I found the following books to be useful when evaluating the chemical hazards present within the Burlington school system.

"Sax's Dangerous Properties of Industrial Materials", eighth edition, 1992, Richard J. Lewis, Sr. editor, Van Nostrand Reinhold, New York, New York.

"Handbook of Toxic and Hazardous Chemicals and Carcinogens", third edition, 1991, Marshall Sittig editor, Noyes Publications, Park Ridge, New Jersey.

"Fire Protection Guide to Hazardous Materials", eleventh edition, 1994, National Fire Protection Association, One Batterymarch Park, Quincy, Massachusetts 02269.

Flinn Scientific Supply Catalog, Batavia, Illinois 60510, (800)452-1261 - Chemical Storage Guidance.

"Pocket Guide to MSDS's and Labels", and "Pocket Guide to Your Right to Know", Business and Legal Reports, Inc., 39 Academy St., Madison, CT 06443, (800)727-5257.

3. Potential sources for written guidance describing school EHS issues:

The Maryland Department of Education has publish a number of helpful technical bulletins describing potential EHS issues in schools as well as potential corrective action.

Maryland Department of Education Office of Administration and Finance Office of School Facilities 200 West Baltimore Street Baltimore, Maryland 21201 (301)333-2508

The Center for Safety in the Arts monitors and evaluates a broad range of health and safety concerns involving the arts and theater. This group has also published a large volume of health and safety guidance.

Center for Safety in the Arts 5 Beekman Street, Suite 820 New York, New York 10038 (212)227-6220

The National Microscale Center at Merrimack College has prepared guidance describing the benefits as well as how to initiate a microscale curriculum. The center also conducts training for those wishing to develop a microscale program.

Dr. Mono M. Singh, Director The National Microscale Chemistry Center 315 Turnpike Street Merrimack College North Andover, Massachusetts 01845 Telephone: (978)837-5137 Fax: (978)837-5017 e-mail at 'msingh@merrimack.edu'.

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Chemical Management
Asbestos Management
Indoor Air Quality
Pesticide Usage
Mercury Management
Radioactive Materials
Fire Prevention
Pollution Prevention
Hazardous Waste
Formaldehyde
Radon
Chemical Fume Hoods
Eye Washes
Safety Equipment
Hazards By Department
Emergency Response
Ceramic Kilns
Underground Tanks
Classroom Lasers
Sanitary Drains
EHS PRIMER

A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Asbestos Management

I. The Issue:

Asbestos is an inorganic mineral that was routinely used in building construction in the United States until approximately 1980. Common uses included insulation, fire proofing, sound proofing, ceiling and floor tiles, the lining of heating and ventilation ductwork, window glazing, and adhesives. In a solid and undisturbed state, asbestos poses minimal hazards and is very resilient. However, asbestos is a significant respiratory hazard and carcinogen when damaged and transformed into a dry friable (crumbly) material capable of generating small fibers that may be inhaled.

Due to the widespread use of asbestos and the frequent discovery of damaged and friable asbestos containing materials (ACM) in schools, the federal government adopted the Asbestos Hazard Emergency Response Act (AHERA - 40 CFR 763) in 1987. This regulation required that all schools be surveyed for asbestos by a licensed inspector. In addition, each school system was required to label and identify all ACM present in each school and to prepare and implement a routine inspection and maintenance program to ensure the long term monitoring and maintenance of all ACM. The intent of AHERA was to control or eliminate the respiratory hazard posed by damaged asbestos in schools by promoting the prompt discovery and removal or encapsulation of these materials. Also, AHERA required the labeling of all ACM and mandated worker notification for all activities occurring in areas where ACM is present. The federal government hoped that these steps would minimize future disturbances of asbestos as the result of site construction, renovation or utility installation.

The following is a general outline of the basic requirements that each school system must implement in order to comply with AHERA.

1. Arrange for the school to be inspected by a licensed asbestos inspector.
2. Identify the location, type and condition of all ACM present in the school.
3. Establish an asbestos management plan or strategy.
4. Warning labels should be posted in all routine maintenance areas to advise maintenance personnel that ACM is present in the school.
5. Prepare a blueprint or schematic indicating the type and location of all ACM present in the school for reference by maintenance and utility workers, construction workers, and emergency responders.
6. Train and designate someone to supervise the implementation of the asbestos management plan.
7. Train auxiliary staff (usually custodial) to assist with the required self

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inspection and monitoring portion of the management plan.
8. Notify in writing and retain a copy of the notification of all utility workers and other personnel working in areas where ACM is present.
9. The school department must self inspect the ACM at each school at least once every six months. Any damaged asbestos noted at this time should be remediated or removed upon discovery. The school department is also required to maintain a written record of these activities for further reference.
10. The school department is required to have a licensed asbestos inspector survey each school where ACM is present every three years as a means to review and monitor the self inspection program implemented by the school system.
11. The school department must ensure that all custodial, maintenance, and utility workers who may work in an area where ACM are present have received at least a basic level of asbestos awareness training prior to working in areas that may contain ACM.
12. The school system is required to provide notification to building occupants and users at least once per year that ACM is present in the building. This notification should also provide a brief description of the asbestos maintenance program or where this information is available for review.
13. The school system is also required to retain accurate records which describe all asbestos monitoring, maintenance and abatement activities. This includes all activities involving cleaning, monitoring, repair or abatement.

II. The approach taken:

In response to the adoption of AHERA, the Burlington School Department had all local schools surveyed by a licensed asbestos inspector for ACM in 1988. Various types of asbestos were found to be present in all local schools. In response to this investigation, the School Department sought and obtained additional funding to reportedly remove the asbestos detected in the schools. It is unclear how this proposal was presented and the full extent of the abatement effort that was planned or implied at this time, however the consensus opinion was that all ACM was to be removed at this time. Based on available records, it appears that the School Department discontinued monitoring asbestos in the schools upon completion of this abatement effort.

In May 1995, the Board of Health became actively involved with asbestos management in the schools after the School Department sought assistance in disposing of asbestos waste generated by their staff. An investigation of the origin of this material determined that the untrained custodial staff had removed damaged boiler insulation at two schools and re-located the material to a third school for storage. These activities were conducted without the use of containment, decontamination, or protective equipment. In addition, the ACM was removed in a dry state with hand tools and packed in two cardboard boxes and five plastic trash bags. None of these containers were sealed or labeled to indicate their contents during transport or initial storage. Also, when I first inspected the containers, I noted that

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the general area around the open containers was visibly contaminated with a fine gray dust presumed to be asbestos. Based on this discovery, I contacted the Massachusetts Department of Environmental Protection (DEP) and Department of Labor and Industry (DLI) for assistance. Since all abatement activities had concluded the sole regulatory question remaining at the state level was the authorization to dispose of the asbestos waste. DEP readily granted the School Department a waiver to dispose of the material and encouraged the staff not to do this again. The Board of Health and DLI acted jointly to order the School Department to have an asbestos abatement firm collect wipe samples at each school to assess the extent of the remaining asbestos contamination and to have each contaminated area decontaminated.

This incident also prompted the Board of Health to review all existing records regarding the assessment and management of ACM within the school system. This investigation determined that contrary to popular belief significant quantities of ACM still existed at all the public schools. Some of these materials were found to be damaged and friable. In addition, no records could be located to indicate if any asbestos management activities or training had occurred at the local schools between 1989 and May 1995. In response, the Board of Health ordered the School Department to have all the public schools inspected by a licensed asbestos inspector and to re-institute the asbestos management plan required by AHERA. The Board of Health now also requires the School Department to submit a copy of all semi-annual self inspection reports, asbestos abatement reports, and training records.

III. Observations made:

The most significant observation I have noted to date is the continuing lack of an accurate and complete outline of where all asbestos containing material is present in each school. Even though each public school has been inspected by at least two different state licensed asbestos inspectors, we continue to discover new ACM at the schools. This suggests to me that the inspectors may need additional training to improve the quality of their reviews, and that each school system should realize that these reviews may not locate and identify all ACM present at the school. Furthermore, each school system may also wish to assume a more assertive and proactive approach when monitoring or abating these problems to compensate for this degree of uncertainty.

I have also detected a pervasive belief among the maintenance staff and school administration that the asbestos hazard has been severely exaggerated by the media and governmental agencies. Much of the staff approach asbestos management as more of a bureaucratic paper shuffle than a step toward protecting public health. This attitude and approach has a major impact in how the school system implements and complies with AHERA. This also impacts whether the required worker notifications are made prior to utility work or renovations, or whether contingency planning is conducted prior to initiating renovations. Failure to pre-plan in both cases can easily result in the uncontrolled release of asbestos. I also believe the low level of concern expressed by state personnel during the investigation of improper asbestos abatement activities conducted during the spring of 1995 re-enforced the belief that the asbestos hazard has been overblown.

Another noteworthy observation is that ACM is present in a number of high traffic areas where accidental damage or vandalism could easily occur. I am not talking about floor tiles but instead asbestos pipe insulation. The concrete or grouted joint insulation is usually fairly durable but the paper type insulation is fairly fragile. I have found this type of material on exposed pipe runs located in locker rooms, offices, restrooms and workshops. In one workshop, I found that students and staff had severely damaged the pipe insulation by placing wood and other materials on the pipes to create storage shelves. This modified storage arrangement most likely resulted in the release of some asbestos into this area. A phased removal and replacement of these materials appears to be the wisest approach for eliminating the hazard created by pipe insulation in high traffic areas.

I have noted that even with re-newed interest in asbestos management much of the ACM within the local schools has not been identified and labeled as required by AHERA. Due to the amount of computer cable installation and renovation occurring in the schools, there is a major concern that these activities could easily result in the release of asbestos if the workers are uncertain of where the ACM is or what is ACM. This may pose a greater health risk to the individual workers, but it also represents a significant regulatory and civil liability for the school department as well.

A troubling and problematic discovery was the detection of asbestos insulation (transite) on the heating and ventilation ductwork in one school. Our research has determined that in the late 1960's and early 1970's it was common to line underground ductwork with transite to make it more durable. Our discovery was made by a heating and ventilation specialist, and not by an asbestos inspector. I encourage all schools to review their heating and ventilation plans to see if this hazard exists at their school. This can be of critical importance for maintaining indoor air quality. Many schools consider ductwork cleaning to be a first step to maintaining indoor air quality but if you apply abrasive chemicals, a wire brush or vacuum system to a transite lined ductwork then you may be releasing asbestos fibers into the school, and as a result, your efforts will result in a significant degradation of indoor air quality. I encourage you to have both a heating and ventilation specialist and an asbestos inspector review this issue for your school system.

Finally, I have also noted a number of areas in the local schools where ACM may be routinely exposed to water damage. This causes concern because the repetitive exposure of ACM to water increases its rate of degradation and increases the likelihood of a release. The following types of ACM are susceptible to water damage: acoustical tiles, ceiling tiles, pipe insulation, certain types of fire proofing and insulation, boiler insulation and joint insulation. I recommend that you a)identify where your ACM is present, b) determine if water damage is present or likely, c) take steps to control or prevent water damage, and d) if water damage cannot be prevented or the damage is beyond repair - remove the ACM.

IV. Problems or concerns noted:

- The variable quality and diligence of the in-house asbestos monitoring program.
- The continued discovery of additional ACM at local schools increases the level of uncertainty associated with asbestos management while also decreasing the likelihood that we have identified all potential risks.
- Several persistent roof leaks in local schools may result in damage to nearby ACM.
- The common belief that most or all ACM has been totally removed from the schools has hampered the efforts to re-invigorate asbestos management at the schools.
- The haphazard notification that ACM is present in the schools increases the possibility that ACM could be damaged and released during utility installation or site renovation.

V. Actions taken:

A. Re-inspected all local schools.

In 1995, all local schools were re-inspected by a state licensed asbestos inspector. The purpose of this inspection was to identify the type, location and condition of all ACM present in each school. As required by AHERA, this step will be repeated in 1998.

B. Prepared a schematic for each school which outlines the type and location of ACM present in the building.

A blueprint has been prepared for each local school which outlines the location and type of all ACM known to exist within the building. It is the responsibility of the School Facilities Maintenance Director, as the plan manager, to use this document to notify all workers prior to allowing them to work in an area where ACM is present. The Maintenance Director is also responsible for updating the schematic as more ACM is discovered or removed.

C. The school department has designated the Facilities Director to manage the plan.

The School Department Director of Facilities Maintenance has been designated the individual responsible for supervising the implementation of the local AHERA plan. In this capacity, he is responsible for directing all local asbestos management activities at the local schools as required by AHERA. In order to fulfill the responsibilities of this role, this individual has been required to complete the the 16 hour asbestos management training specified by AHERA.

D. Additional staff training.

All members of the custodial staff have completed at least two hours of asbestos awareness training to enable the staff to identify ACM and to inform them of pertinent asbestos management protocols. The roll of these staff members is to simply report the discovery of new ACM or a change in existing ACM to the coordinator. In addition, two members of the custodial staff have also completed additional asbestos training to enable these staff members to conduct small asbestos abatement or repair activities involving less than 3 linear feet of material. All repair and abatement activities must be supervised by the Director of Facilities Maintenance and conducted in accordance with all applicable state and federal safety standards. All larger abatement or repair activities must be completed by a state licensed asbestos abatement firm.

E. The asbestos management plan required by AHERA has been re-instituted.

Efforts have been implemented to re-invigorate the local asbestos management plan. As a result, staff training has occurred, self monitoring and inspection is now taking place, and some notification is being provided.

Lessons learned:

The following is a summary of significant lessons I noted during my investigation of asbestos management at the Burlington public school system.

1. ***Identify common types of ACM used in your area and make sure your school was surveyed for all of these materials.*** This approach will enhance your ability to accurately locate and identify all ACM present at your school.

2. ***Review all inspection reports and abatement records to verify what ACM remains.*** There is no substitute to verification when attempting to determine what ACM exists at your schools. All inspection and abatement reports should be carefully reviewed and compared to the building schematic.

3. ***Learn about the types of ACM and attempt to quantify hazards.*** Developing a better understanding about the uses, types, and durability of ACM will improve your ability to manage the ACM present at your school. This basic knowledge will enhance your ability to estimate the maintenance issues or hazards associated with various types of ACM. You should be able to begin to recognize some of the differences associated with the different types of ACM (e.g. asbestos pipe insulation - fragile, potentially friable asbestos with a higher risk of release when damaged versus floor tiles - durable, non-friable asbestos with a lower risk of

release).

Tips and suggestions:

1. ***Seek assistance from local community.*** Tap the knowledge and expertise of the local community. They have a vested interest as parents and taxpayers. This interest may also bring more dedicated assistance. Also, this assistance is usually free. Also, local builders and contractors frequently have a detailed knowledge of past and current building and maintenance practices which may not be well documented in existing schematics or construction records. It was a local volunteer who informed us of the use of transite asbestos in the construction of heating and ventilation ductwork after numerous consultants had reviewed the same material.

2. ***Use a phased approach based on risk of release, location, and to a certain extent on cost to plan abatement activities.*** Due to the widespread use of ACM, it is usually not economically feasible to remove all ACM from a school. In addition, abatement activities may create more of a hazard than would normally exist if the ACM were simply protected and maintained in good condition as is the case for ceramic floor tiles. Therefore, a balanced approach based on the hazard posed by the ACM, its location, and to a lesser extent the cost of abatement should be used when planning asbestos repair or removal activities.

Resources:

During this investigation, I utilized the resources available via the U.S. Environmental Protection Agency and the Massachusetts Departments of Environmental Protection, Health , Labor and Industries. I also reviewed guidance information prepared by the U.S. Department of Labor Occupational Safety and Health Administration. Due to regional differences with regard to the management and handling of asbestos and asbestos waste, I recommend that you consult with your state environmental, health, and occupational hygiene offices, and the regional EPA and OSHA offices prior to initiating asbestos abatement and management activities.

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Chemical Management
Asbestos Management
Indoor Air Quality
Pesticide Usage
Mercury Management
Radioactive Materials
Fire Prevention
Pollution Prevention
Hazardous Waste
Formaldehyde
Radon
Chemical Fume Hoods
Eye Washes
Safety Equipment
Hazards By Department
Emergency Response
Ceramic Kilns
Underground Tanks
Classroom Lasers
Sanitary Drains
EHS PRIMER

A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Indoor Air Quality

I. The Issue

In the past twenty years, health officials have noted that indoor air quality can have a significant impact on the health and well being of an individual. In addition, we have learned that our recent efforts to improve heating and cooling efficiencies have also influenced air quality in many buildings including schools. As we seal buildings and reduce the rate of fresh air exchange in order to maximize our heating and cooling efforts, we have created an environment that is conducive for the build up of indoor contaminants related to our own activities. Examples of some of the common contaminants include: tobacco smoke, carbon dioxide from human respiration, carbon monoxide from inefficient heating, chemical emissions from classroom activities, maintenance activities, or off gassing from building materials or furnishings, and hydrogen sulfide released via sewer lines. In addition to chemical contaminants, biological contaminants such as bacteria, fungus, and mold may also be present in elevated concentrations in indoor air. Biological contamination is likely to occur in areas that are frequently subject to flooding, high humidity, water intrusion or repeated leaks. Pollen and animal dander are additional biological agents that may also impact indoor air quality.

The presence of these contaminants does not mean that you will automatically experience an adverse health effect. However, numerous studies have determined that exposure to these contaminants can result in an increased incidence of the following types of ailments in the exposed population: asthma, allergies, chemical and biological sensitivities, sinus infections, headaches, nausea, chronic coughs, respiratory distress, and potentially cancer. The duration and intensity of exposure and sensitivity of the individual will determine if an effect will occur.

Finally, due to the increased use of synthetic material in the construction of building materials and furnishings as well as the widespread use of chemicals in school curricula and maintenance activities, it is imperative that we monitor and reduce the potential impact of these materials on the building occupants. In addition, since the energy crisis of the 1970's, many school systems have actively implemented measures to seal their buildings and reduce fresh air exchange. In many cases, this approach may have created an environment which promotes the build up of indoor air contaminants while at the same time exposing children to the hazards associated to these materials. Another factor to the equation is that children are at a high risk to sensitization and biological response because of their metabolic rate and developmental stage. In basic terms, children

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have a higher metabolic rate than adults and consequently have a higher rate of respiration, as a result they inhale more air and potentially greater amounts of any contaminants present in the air. Also, children are at risk because their bodies have not fully developed and matured. This means that depending upon their age, they may lack much of the de-toxification capabilities that an adult has. Therefore, we have strong incentives to monitor and improve indoor air quality at local schools in order to protect our children's health as well as that of their teachers.

II. The Approach Taken:

Since the mid-1980's the Board of Health routinely received complaints from parents and staff that the air in the local high school was "bad". These complaints centered on the report of chemical odors, stale air, no air movement, and the report of increased medical symptoms such as allergies, sinus problems, and asthma. We also received a number of comfort complaints associated with the indoor temperature and humidity. Over time we could not determine a specific pattern or location for these complaints other than a general increase during the winter months. Also, the variability and vagueness of the complaints as well as our method of recording these complaints initially hindered our ability to thoroughly investigate these reports.

Early on, we recognized that in most cases thermal complaints involving room temperature did not pose a risk to indoor air quality. Thermal problems represent a personal comfort issue which may cause an individual to be more sensitive to a real or imagined air quality concern but tend to have minimal impact on overall indoor air quality. As a result, we empathized with the staff's desire for individual temperature control but in general we placed a lower level of importance on resolving these complaints. Our primary focus was to identify and resolve the source of chemical odors reported in the building. This approach was reactive in nature. We would investigate in response to complaints rather than trying to identify and prevent potential problems from occurring. These investigations determined that the arts, science, and maintenance departments were the sources of most of the odors detected in the school.

While conducting a chemical hygiene assessment of the materials used by the staff, I began to realize the potential impact that the use of these substances could have on indoor air quality at the school. This discovery prompted a more a comprehensive and proactive approach to preventing impacts on indoor air quality. These efforts included the initiation of staff reviews of chemical usage, materials substitutions, greater use of mechanical ventilation, and the re-scheduling of maintenance or laboratory activities. During this phase, we identified the following activities as having a potential adverse impact on indoor air quality at the high school. The use of volatile solvents and biological specimen preserved in formaldehyde was found to be a common source of odor complaints involving the science department. Another cause of complaints was the heating of laboratory experiments without using additional mechanical ventilation. The uncontrolled release of free silica from clay powder and toxic heavy metal colorants used in the ceramics program represented the most significant indoor air quality concern in the arts department. Free silica is comparable in both chemical and biological behavior to that of asbestos. The fine heavy metal powder colorants represent a significant respiratory hazard and some are potentially carcinogenic or teratogenic. The indoor use and application of paints, pesticides and solvents were found to be the source of the majority of the odor complaints submitted with regard to maintenance activities.

In 1992, the Board of Health adopted a municipal bylaw which regulated smoking in public places. A provision of this regulation banned smoking within the local schools. In 1993, the Massachusetts Department of Public Health banned smoking on all school grounds and at all school functions. These steps virtually eliminated the generation of second hand tobacco smoke within all local schools.

In the spring of 1993, I expanded my indoor air quality review to include the identification and inspection of potential sources of emissions within the schools. This effort lead to the identification of five ceramics kilns utilized by the school department. Initially, none of the kilns was vented to the outdoors. This effort also included a general inspection and review of the chemical fume hoods utilized by the high school science staff. The majority of these units were found to provide little noticeable air movement when operated. This prompted the initial recommendation to have these units professionally inspected, repaired and re-calibrated.

Also in the spring of 1993, the Massachusetts Department of Labor and Industries (DLI) contacted the Board of Health with regard to indoor air quality complaints submitted by the high school faculty. In response, DLI and Board of Health staff inspected the school. At the time, it was reported that all heating and ventilation maintenance and repair activities were subcontracted and as a result no maintenance records were available for review. Neither agency was able to gain access to records which described the maintenance and repair of the heating and ventilation system at this time.

In September 1993, the school department hired a private consultant to inspect and repair the chemical fume hoods present in the science laboratories. This investigation determined that 8 of the 12 hoods were inoperative and in need of repair. The main problem noted was that fans had been removed from the units or that fans had burned out.

In July 1995, a representative of the Massachusetts Office of Technical Assistance noted the presence of mold and bacterial contamination during an inspection of the high school science area. This report also provided comments regarding the æstuffiness' of the air in this portion of the school.

Continuing concerns regarding the status of the chemical fume hood utilized by the high school science department caused the School Department to hire another consultant to inspect the units. This investigation determined that only 3 of the units were operational.

In December 1995, the Massachusetts Department of Labor and Industries returned to the high school in response to continuing staff complaints regarding poor air quality. Again, no maintenance records were available to describe the current condition of the heating and ventilation system.

In May 1996, staff complaints prompted the school department to hire a consultant to determine the source of chemical odors in a portion of the building. The consultant determined that art classes in adjoining classrooms were the source of the solvent odor complaints filed by the staff. Mineral spirits had been used for several days by the staff and students without the aid of mechanical ventilation.

Persistent complaints by the high school teachers' union caused the School Department to hire a consultant to conduct an indoor air quality assessment at the school in October 1996. The primary focus of this effort was to measure the carbon dioxide and carbon monoxide concentrations, temperature and humidity within the classrooms in order to gauge the function of the heating and ventilation system. This study also included limited efforts to identify potential allergens within the study area.

In the fall of 1996, a number of parents and staff members lost patience with local efforts and filed complaints with the Massachusetts Department of Public Health and the U.S. Environmental Protection Agency. In response, both agencies contacted the Board of Health to learn of local efforts to evaluate the indoor air quality at the local high school. In addition, the Massachusetts Department of Public Health offered its assistance in conducting air quality sampling at the school. As part of this effort, representatives of the Massachusetts Department of Public Health and the Burlington Board of Health conducted air quality sampling in approximately 50 classrooms in the school. The focus of this monitoring effort was to measure the carbon dioxide concentration, humidity, and temperature within the school. A general survey of potential allergens or other potential indoor air quality concerns was also conducted at this time.

Due to the expanding interest in the air quality investigation, the Board of Health decided that a public forum was the best approach to ensure a comprehensive review of the existing conditions and to answer the questions of the general public. As a result, the Board of Health convened a public hearing in February 1997 during which the general public was offered the opportunity to discuss its concerns regarding the indoor air quality with the School Committee and representatives of the Massachusetts Department of Public Health and the U.S. Environmental Protection Agency. This event solidified community support for investigating and resolving the problems while also eliminated the possibility for the School Department to continue ignoring the issue. A by-product of the public forum was the adoption and implementation of the indoor air tools for schools assessment protocol. The indoor air tools for schools is a comprehensive indoor air quality assessment guide prepared by the U.S. Environmental Protection Agency. As part of this

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effort, an indoor air quality assessment team consisting of concerned parents and staff was also assembled to assist with the implementation and interpretation of the indoor air tools for schools survey results. In addition, the Town also hired a professional assessment team consisting of an architect, a heating and ventilation specialist, and certified industrial hygienist, to ensure the completion of a comprehensive assessment and the development of a response plan.

This evaluation resulted in the identification of a number serious indoor air quality concerns. The results of these reviews were used to develop a response plan. In May 1996, a request for approximately $1.2 million dollars was submitted to and approved by the Burlington Town Meeting to fund the repair of the heating and ventilation system at the school. A variety of response actions are now in progress.

In January 1998, the Board of Health began reviewing air quality complaints involving a local elementary school. These complaints were related to the lack of adequate air exchange and the possible presence of allergens within the classroom.

III. Observations Made:

The most significant observation made was failure or unwillingness by local officials to recognize and acknowledge that obvious maintenance shortfalls could adversely impact indoor air quality at the high school. Chronic and widespread roof leaks had been a major problem at the school for years. Evidence of this problem in the form of mold, mildew, musty odors, and rusted fixtures was readily available throughout the building. In addition, there were a number of areas in the building which were commonly known to be æstuffy', yet few wanted to accept that the number and broad range of complaints could be associated with these problems.

Another critical point has been the unwillingness of the staff considering how their actions can impact indoor air quality. A number of activities have been identified involving the arts, science, and maintenance staff which can adversely impact the air quality. Many of these problems have been reviewed with the individual staff members and discussed during training sessions. Furthermore, many staff members complained about their colleagues' activities during the survey portion of the indoor air tools for schools assessment. Unfortunately, most staff members have chosen to ignore or downplay these complaints when approached. This issue could become increasingly problematic as the repairs to the physical plant are completed and these odor complaints remain unresolved.

During this review, I also noted that the staff tended not to commonly use chemical fume hoods present in the high school. This practice may have been related to the perpetual state of disrepair that many of these units displayed. In addition, the continuing inability of the repair contractors hired by the School Department to properly inspect and repair the hoods supports the need to hire competent professionals skilled and experienced in the task that they are requested to complete. In our case it took four years and four different consultants to fully assess the problems associated with the hoods and to develop a comprehensive response plan so that these units could be returned to full operation. Our first three consultants examined only portions of the hood system. Most checked the status of the exhaust and intake fans. Most did not test the integrity of the hood unit or the ductwork, and only the last consultant reviewed the actual design of the units. As a result, several consultants certified the hoods based on exhaust air movement only with out regard for whether the units leaked emissions or if the exhaust could re-enter the building. The final assessment noted that all hoods possessed the design flaw of having their exhaust located near their intake so that hood emissions could re-enter the building via the intake. As a result, even if fully functional, none of the hoods could be safely operated.

A survey of the five ceramics kilns utilized by the School Department found that all of these units initially to vented directly into schools. This may have resulted in the release of carbon monoxide, volatile organic compounds, and metal fumes into the schools. We were able to quickly provide proper ventilation to the units located at the local elementary and middle school. Unfortunately, at the high school, it took more than two years to equip the kilns with the appropriate mechanical ventilation needed to properly vent the emissions generated by the units. These difficulties further support the need to use skilled professionals and to adhere to state, federal or industry standards when investigating and resolving these issues.

Due to the chronic and widespread problem of roof leaks, biological contamination was found in a number of locations at the high school. Mold, mildew, and bacteria were found growing in carpets, on books, ceiling tiles, and in insulation.

The final comprehensive assessment of the heating and ventilation system found the high school ventilation system to be in a serious state of disrepair. Portions of the system were found corroded or irreparably damaged. The review team also noted that the fiberglass lining of some of the ductwork was slowly degrading and could begin to release fibers if not abated. This evaluation also observed that building renovations had occurred since the original construction of the heating and ventilation system. As a result, some sections of the build had not be connected to the ventilation system during renovation. We also found that some renovated areas had been connected to the ventilation system using flexible ductwork which had collapsed and consequently eliminated our ability to provide adequate fresh air to these areas.

The professional review team also uncovered a flaw in the heating and ventilation system design. The current construction places the air intakes and returns on one wall of each room in an alternating sequence. The positioning of these units promotes short circuiting with air entering the room via the intake and with a portion of the supply air immediately exiting via the adjacent return. In addition, it was also determined that the existing ventilation system was not capable of moving fresh air completely across many of the rooms. This may have resulted in the creation of a stagnant area on the far side of the room where little fresh air exchange occurred.

A discovery noted by a community representative on our indoor air tools for schools air quality team was the presence of transite asbestos insulation lining some ventilation ductwork in the school. This observation provided the School Department with another location to be included in their asbestos monitoring program. More importantly, this discovery raised new concerns regarding how and when to clean the heating and ventilation ductwork without creating a serious health hazard.

A more recent discovery has been that of the removal of unit ventilators at a local elementary school. These units were reportedly removed in the 1980's as a means to improve energy efficiency. Unfortunately, this step has also eliminated the only means to mechanically ventilate the building, and as a result further investigation may determine that the lack of air exchange may result in poor air quality at the school. Realistically, this issue should be reviewed at all local schools which have similar heating and ventilation systems.

IV. Problems or Concerns Noted:

- The high school was originally designed to rely solely on mechanical ventilation. The bunker like design of the building drastically limits our ability to use passive ventilation to improve the air exchange in the building. Many of the classrooms were constructed without windows and few of those windows provided can be opened.
- Flaws in the original design for the heating and ventilation system resulted in the creation of stagnant areas in many rooms in the building.
- The failure to properly balance and maintain the high school heating and ventilation system placed additional constraints on the ability of the system to provide adequate ventilation.
- A design flaw and poor maintenance limited the effectiveness of the chemical fume hoods present in the high school.
- Problems with the ventilation system combined with the indiscriminate use of chemicals by the staff has resulted in the build up of contaminants and detection of nuisance odors in the building.
- Chronic roof leaks at the high school has promoted the growth of mold and bacteria. These contaminants represent serious potential respiratory allergens that may affect the school population.
- A number of exhaust fans and ventilation units have been removed

or disabled at local schools in order to promote energy efficiency. This practice may have had a significant impact on our ability to properly ventilate the local schools.

- Based on past experience, we need to establish a more effective approach for preventing and responding to the introduction of chemical fumes into the schools. The school administration routinely dismisses the health and safety concerns associated with these releases even when the identity of and hazards associated with the contaminant are known. Public relations and the ability to control the student populace has tended to dominate the administration's response to these incidents rather than health and safety concerns.

V. Actions Taken:

A. The evaluation of the chemical inventory has resulted in the identification and removal of potential indoor air contaminants.

While conducting a chemical hygiene review of the materials maintained at the high school, I noted that a number of materials could have an adverse impact on the indoor air quality. These materials included volatile organic solvents and formaldehyde used by the science department, powdered clay containing free silica and toxic heavy metal powders used by the ceramics program, and solvent based cleaners and pesticides used by the maintenance staff. Upon review of the complaints received by the Board of Health, we determined that the organic solvents and formaldehyde used by the science staff as well as the maintenance materials and pesticides used by the maintenance staff were responsible for the majority of the objections raised by the staff. In addition, a review of the health hazards associated with these problem materials indicated that these materials were carcinogenic, narcotic, flammable in nature, and the pesticides were found to be intended for outdoor use only. Based on this information, the bulk of these materials were deemed inappropriate for use at the school and disposed of as hazardous waste.

B. A chemical use review policy has been adopted.

In response to the potential problems noted during the chemical hygiene review, the School Committee and Board of Health have worked together to develop a chemical use review policy which now requires the staff to evaluate procedures involving chemicals for the following parameters: 1) hazards associated with the chemicals, 2) potential impact on air quality, 3) protective equipment or safety procedures required, and 4) the generation of hazardous waste. It is hoped that this practice will help to identify and promote the elimination of potential air contaminants. Resistance to change expressed by some staff members has limited our ability to achieve the full potential of this policy.

C. All ceramic kilns were equipped with mechanical ventilation.

Initially, all five ceramic kilns operated by the school were found to vent directly into the school buildings. The practice offered the potential for volatile organic materials, metallic fumes, and carbon monoxide to build up in the buildings. This problem was corrected by connecting each kiln to a mechanical exhaust system which vented directly to the outdoors.

D. Several air quality assessments were conducted at the high school with mixed results.

Since 1992, several air quality assessments have been conducted at the high school. These efforts were all initiated in response to complaints submitted by either parents or the staff. The typical approach taken is to measure the carbon dioxide content and the humidity of occupied classrooms to assess the general ability of the heating and ventilation system to provide adequate air exchange in the building. The premise behind this assessment is that the occupants generate carbon dioxide and if the ventilation system is not functioning adequately then the carbon dioxide concentration will increase. This is a reasonably easy and inexpensive qualitative assessment tool. The most effective time for conducting this type of evaluation is when the heating and ventilation system is stressed such as during the winter heating season in the Northeast. Unfortunately, many of the investigations sponsored by the School Department were conducted during the non-heating season (late May or early October). The results of these evaluations were invalidated by the fact that the ventilation was set for maximum fresh air intake at the time of both investigations. Also, a greater amount of passive ventilation was possible during these times due to the routine practice of where possible opening windows and doors to augment the building ventilation during warm weather. These two events would not be likely during the winter months when few would want to introduce cold air into the building.

In comparing the results of the air quality assessments conducted by the School Department consultants to those studies conducted by the Massachusetts Department of Public Health and the Burlington Board of Health, it is likely that the introduction of additional fresh air during the warmer months skewed the results of those investigations. The studies conducted during the warmer months rarely indicated a problem with the ventilation system, however studies conducted during the heating season found that approximately half the classrooms developed carbon dioxide concentrations which exceeded the Massachusetts Department of Public Health guidelines for schools.

E. We implemented the EPA Tools for Schools Indoor Air Quality Assessment Program.

The tools for schools air quality assessment program provides the layman with a comprehensive guide for initiating an indoor air quality assessment. This package identifies potential areas of concern while also providing structure to your investigation. I wish I had these tools in 1993 or 1994 rather than in 1997. By the time we adopted the indoor air tools for schools, we had already identified a number of problems as well as the areas that required further review. If we had used this guide earlier our investigation could have been better focused and more efficient. An additional benefit of the indoor air tools for schools approach was that it seeks to maximize the number of individuals involved with the assessment process. This tends to ensure a comprehensive and open investigation that is conducive to brainstorming and discussion. Negatives associated with the approach are that the survey forms are vague in nature and fine tuning of the questions should be conducted prior to initiating your surveys. Also, as with anything as the committee size increases, it can become difficult to remain focused on the big picture and not get lost in the minutiae.

F. We hired a multifaceted professional review team to assist with the air quality assessment.

We learned from our past short comings and hired a multifaceted review team to assist our investigation. This team consisted of an architect, a heating and ventilation maintenance and repair specialist, and an industrial hygienist. This group proved to be invaluable in promoting the full assessment of the issues present as well as in the development of response plans for the problems noted. In addition, several local residents skilled in the design or repair of ventilation systems assisted these efforts. Their expertise was essential in determining the completeness of the review, the soundness of the response proposals, and the evaluation of the validity of cost estimates.

G. A corrective action plan has been initiated at the high school.

In the summer of 1997, we began to address these problems by repairing the roof leaks at the high school. At the same time, steps were taken to decontaminate areas or remove materials impacted by biological contamination. Once this was completed, we began to repair and modify the heating and ventilation system to improve the fresh air exchange and to eliminate the stagnant areas. The following items are scheduled to be completed in 1998: repair and re-calibration of the fume hoods, removal and replacement of flexible ductwork, and construction of ventilation to new rooms constructed without ventilation. A phased approach has been proposed for encapsulating or removing the fiberglass lining present in much of the ductwork. We intend to address the areas which pose the greatest need first until all fiberglass linings have been removed or encapsulated.

Lessons Learned:

The following is a summary of significant lessons I noted during our investigation of indoor air quality within Burlington public schools.

1. ***Before you can initiate an effective air quality review you need to educate and inform all participants with regard to causes and effects of***

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poor indoor air quality.

A basic level of knowledge of the causes, concerns, and effects associated with poor indoor air quality is required before an efficient and comprehensive investigation can be implemented. I found this to be especially true with regard to the variety of health effects that may be related to poor air quality. The initial response of the Board of Health to air quality complaints was hindered by our limited understanding of the potential number and type of problems that may be manifested by a given population. Initially, we looked for a consistent trend or pattern of symptoms and effects. The failure to detect an obvious pattern lulled hopeful local officials into considering that the problem may be psychological in nature and not the sign of an inherent problem at the school. The school administrator continues to believe that the health complaints reported are not responses to problems present at the school but psychological or conditioned responses submitted by a disgruntled few. A general educational and awareness initiative should be conducted at the start of every air quality investigation.

2. ***Proper maintenance and calibration of the heating and ventilation system is critical to indoor air quality.***

This point is a given but in the age of deferred maintenance programs or sub-contracting services to the lowest bidder, it is easy to find many facilities where this step is overlooked. To put it bluntly, if you do not provide a proper rate of fresh air exchange or mechanically exhaust chemical contaminants introduced by the building occupants then a potentially hazardous level of contaminants will accumulate in the building with a resulting decline in air quality.

3. ***The heating and ventilation system should be inspected and repaired by a qualified professional.***

The use of inexperienced and unqualified contractors to attempt to inspect and repair the chemical fume hoods and ceramics kiln exhaust at the high school lead to a more than five year delay in fully assessing the extent of the problems. These delays prolonged the potential introduction of contaminants into the indoor air via the failed exhausts, leaky ductwork, and re-entrainment of materials via the intakes of the units. In addition, each time a new contractor attempted to repair the units, the School Department came away with a false sense of security because their contractor had assured them the units were functioning properly. Remember you get what you pay for.

4. ***Investigate all steps taken in the name of energy savings.***

Many actions initiated to promote energy efficiency can have a detrimental impact on indoor air quality. A common approach has been to seal buildings to prevent passive ventilation or to remove or disconnect exhaust fans to reduce mechanical ventilation. The net result is that we have created an environment where contaminants can accumulate while also

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having a lesser ability to actively remove the contaminants. Two local approaches to enhancing energy efficiency that I have noted have included the removal of fans from chemical fume hoods as well as the removal or disabling of unit ventilators at a local elementary school. Both steps may have crippled our ability to provide adequate mechanical ventilation.

5. ***Thoroughly record complaints received.***

All air quality complaints should be thoroughly recorded. We now make an effort to record the following information whenever we receive and air quality complaint: name, age, sex of the individual, any pre-existing conditions or allergies that may affect the symptoms reported (e.g. asthma), building name or address, room number, a description of any recent activities in the building or school that may have prompted the complaint (e.g. chemical usage, construction), time, and date of the complaint. We are also working with the school nurses in an effort to track medical complaints reported in the schools. We are hoping to use this information to identify sections of schools or individual rooms that may display a higher concentration of allergic or asthmatic responses or headaches.

6. ***A policy must be established for responding to the detection of chemical odors within a building.***

On several occasions chemical odors or clouds have been detected at the local high school. In each case the identity of the material was known to local officials. In each case the school administration may have placed the students and staff at risk by postponing or not evacuating the affected areas. The administration reportedly felt that they would lose control of the students if full or lengthy evacuations were implemented. The administration was also skeptical of the potential health effects the materials posed to the building occupants. My recommendation is to avoid this potential conflict during what will already be a stressful situation and pre-plan for how to respond to a chemical release within the building. Once you have adopted a policy and trained your staff, the implementation should be almost automatic.

7. ***Before you attempt to clean your heating and ventilation system you must determine if the ductwork of your system is lined with a potential hazardous material.***

Once people buy into the idea of inspecting, cleaning and repairing a ventilation system there develops a sense of urgency to do something. In many case, that something is clean the ductwork. This is usually accomplished by running a wire brush-like implement through the ductwork and then removing the dislodged material via a vacuum. This can be useful to remove dirt and other organic matter (e.g. leaves) from unlined ductwork. Unfortunately, this approach can also create more significant health hazards if conducted in ductwork that is lined with asbestos or fiberglass as was present in Burlington. Fortunately, we did not choose to initially clean the ductwork, but if we had we could have released a large volume harmful mineral fibers into the school. Know what you are getting into before you begin.

8. ***When all else fails use a coordinated and public process to review and discuss the issue.***

Between 1991 and January 1997, our investigation languished due to the general acceptance by local officials that the air at the high school may be poor but æhey what can we do about it.' In February 1997, in response to inquiries received from the Massachusetts Department of Public Health and the U.S. Environmental Protection Agency, the Board of Health convened a public hearing to discuss the complaints. This forum thrust the issue into the public eye. This event also prompted the School Committee to abandon its position that no air quality concerns existed at the high school and to formally state for the first time that serious problems did exist. In addition, between February and May 1997, the air quality concerns at the high school went from a general nuisance to local officials to a major concern to local residents and then to a unanimous approval by the Burlington Town Meeting to fund a $1.2 million repair initiative to correct the problems identified. Public involvement eliminated the ability to deny that a problem existed while also providing the support to ensure that a comprehensive evaluation and abatement plan were completed.

Tips and suggestions:

1. ***Seek assistance from local community.*** Tap the knowledge and expertise of the local community. They have a vested interest as parents and taxpayers. This interest may also bring more dedicated assistance. Also, this assistance is usually free. Also, local builders and contractors frequently have a detailed knowledge of past and current building and maintenance practices which may not be well documented in existing schematics or construction records. It was a local volunteer who informed us of the use of transite asbestos insulation in the construction of heating and ventilation ductwork after numerous consultants had reviewed the same material without noting this potential problem.

2. ***Seek the assistance and involvement of state and federal agencies.*** I found that the interest and participation of Massachusetts Department of Public Health and the U.S. Environmental Protection Agency provided legitimacy to the investigation. During much of the investigation many of the local officials were willing to dismiss the air quality complaints as inflated or as lacking merit because they were submitted by the dissatisfied. Once the state and federal agencies expressed an interest in the air quality complaints, a number of key local officials experienced a conversion and began to consider that the complaints may have some basis. This change of heart and additional attention provided the motivation to conduct a comprehensive and methodical assessment of the air quality at the high school.

3. ***Use a smoke bomb to test mechanical ventilation.*** This simple and inexpensive test can provide you with a quick and easy qualitative

assessment of the function of a chemical fume hood or kiln exhaust. The use of brightly colored smoke will enable you to easily determine if exhaust may be escaping from the test unit, the ductwork associated with the unit, or if the exhaust is re-entering other portions of your ventilation system. This is only a quick and dirty analysis designed to check for major problems. This approach does not replace the need to have a trained professional inspect, maintain and calibrate these units. This approach can influence many skeptics who do not believe that an air quality problem may exist, especially when they observe colored smoke escaping a mechanical exhaust or moving in directions it should not. Just remember to turn off your smoke alarms before you run your test.

4. ***Review design plans and maintenance records of the suspected heating and ventilation system as a starting point of any air quality assessment.*** This is a critical first step. This will provide you with clues as to how the system is supposed to operate as well as providing you with potential points of concern such as ductwork linings or critical maintenance areas. These plans should also provide designs regarding the intended design and operation of mechanical exhausts in the building. A review of this information may also suggest potential avenues for exhausted contaminants to be re-introduced into the build via air intakes. I suggest that a review team complete this task. The multiple perspectives offered by our team were extremely valuable in identifying a number of different issues that could have been overlooked if only one or two reviewers had completed the task.

5. ***Identify and inspect all potential indoor pollution sources for improper emissions.*** Any building suspected of experiencing an indoor air quality problem should be surveyed for potential indoor pollution sources. Potential pollution sources include: all mechanical exhausts such as chemical fume hoods, spray booths, ceramic kilns, and welding hoods; boilers, computer labs, shop areas, print shops, and animal holding areas. Each of these locations has a number of potential problems associate with it and should be carefully reviewed.

6. ***Test the area for carbon dioxide content.*** This is a quick and inexpensive qualitative screening method that can be used to provide a general assessment of the function of the ventilation system. This approach can be used to help determine areas that may be receiving inadequate ventilation. Remember the most accurate measure will be acquired when the heating and ventilation system is under stress (e.g. during the heating season), when little passive ventilation is available (e.g. when the windows are closed), and when the room is occupied.

Resources:

During this investigation, I utilized the resources available via the U.S. Environmental Protection Agency and the Massachusetts Departments of Public Health ,and Labor and Industries. I also reviewed guidance information prepared by the U.S. Department of Labor Occupational Safety and Health Administration. Prior to initiating an investigation, I encourage you to consult with your state environmental, health, and occupational hygiene offices, and the regional EPA and OSHA offices. These agencies will be able to provide you with an outline of issues and concerns common to your area. In addition, these agencies may also offer free technical assistance which may hasten your evaluation.

1. ***References books:*** During my investigation, I found the following references useful and informative.

"Introduction to Indoor Air Quality - A Reference Manual", prepared by the U.S. Environmental Protection Agency, the U.S. Public Health Service, and the National Environmental Health Association, July 1991, document number EPA/400/3-91/003.

"Tools for Schools Indoor Air Quality Action Kit", prepared by the U.S. Environmental Protection Agency, September 1995, document number EPA 402-K-95-001.

2. ***Internet resources:*** During my review, I found the following websites to be useful and informative.

Address: EXIT EPA	**Site Description:**
http://www.cdc.gov	*NIOSH Info & Toxicological Registry*
http://www.access.gpo.gov	*Federal Government Printing Office*
http://ecologia.nier.org	*35 Environmental Databases*
http://www.aiha.org	*American Industrial Hygiene Association*
http://turva.me.tut.fi/~oshweb/	*Index of Health & Safety Resources on Net*
http://www.ABIH.org	*American Board of Industrial Hygiene*
http://www.siri.org	*EHS Bonanza, MSDS's & Much More*
http://www.baqa.org	*Building Air Quality Alliance*
http://www.epa.gov	*U.S. Environmental Protection Agency*
http://www.osha.gov	*OSHA*

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A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Pesticide Usage

I. The Issue:

By design, pesticides are intended to be toxic to a variety of living organisms. Pesticides are typically manufactured to adversely affect one of the following systems within the target pest: circulatory, nervous, respiratory or reproductive. If the applicator is careless or over zealous in his use of pesticides then additional organisms may be unintentionally exposed to the pesticide. This can be especially problematic when the pesticides are being applied indoors where diffusion and atmospheric dispersion of the toxic materials is severely limited.

Another concern associated with the exposure to pesticides is the potential for these materials to bioaccumulate within living organisms and to persist in the environment. In general terms, bioaccumulation is the process where a substance is taken up or absorbed by an organism and stored in the body. This process can be extended further as you watch how materials may move through the food chain. In some cases, the species at the top of the food chain tend to accumulate and store all the contaminants contained within their prey. The process of concentrating contaminants as you move up the food chain is a form of bioaccumulation and can adversely impact the health of the organism. The problem of persistence is that many pesticides were originally designed to not be susceptible to biodegradation and to last a long time in order to prolong their effectiveness. The issue here is that persistence tends to promote bioaccumulation and to prolong the exposure of all organisms to a toxic material regardless of whether they were an intended target to the toxin. Fortunately, there has been a significant effort within the last ten to fifteen years to consider these two problems and to develop alternative pest management strategies or to develop pesticides susceptible to biodegradation and not conducive to bioaccumulation. However, the legacy of past pesticide usage may continue to pose these concerns for health officials wherever these materials were used.

Recently, there has also been an active discussion of the potential long-term impact of pesticide exposure on the human body. Many researchers are especially concerned about the net effect these materials may have on the reproductive and endocrine systems. Keep in mind that pesticides have naturally evolved or have been synthesized by man to disrupt biological activity at the enzymatic level. As a result, the concern for how chronic exposure to pesticides may effect the body is worthy of concern and research.

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In light of these concerns, it is prudent to assume that where possible, all individuals should make an effort to reduce their exposure to pesticides. In addition, all individuals responsible for the application of pesticides should initiate steps to eliminate or reduce the need to apply pesticides and where this is not possible, efforts should be initiated to seek non or less toxic alternatives.

II. The approach taken:

Initially, our approach was to respond to and investigate pesticide odor complaints as we received them. It soon became apparent that the continued misapplication of pesticides inside the high school posed a potential exposure risk to the building occupants. In response, we made a concerted effort to research and learn about pertinent regulations governing pesticide application. We also attempted to learn how and why the materials were being used in the schools. This caused us to realize that poor housekeeping had created some of the insect problems observed in the schools. We also noted that rather than address the housekeeping problems (e.g. improper food storage in the classroom), the staff would apply pesticides to control the problem (e.g. ants). This observation prompted an educational effort to promote more effective and safer pest control methods.

At the same time, in response to numerous complaints submitted by the general public regarding the application of pesticides in the Commonwealth, the Massachusetts Department of Food and Agriculture completed a major overhaul of state regulation governing the use of pesticides. This action established training and licensing requirements for pesticide applicators as well as notification requirements prior to an application. These regulatory changes clearly defined the qualifications and responsibilities of the applicator. In essence, the Commonwealth established a performance benchmark for all pesticide applicators with the adoption of these standards in 1993.

Finally, in 1995, upon realizing that the school maintenance department did not intend to have a staff member obtain an applicator license, the Board of Health convinced the School Department to dispose of its pesticide inventory and to obtain contracted services for pest management. The Board of Health has not received any pesticide odor complaints since the contracted services have been utilized for pest management within local schools.

III. Observations made:

While inspecting pesticide odor complaints, it became apparent that some of the applicators had not fully reviewed the pesticide label and application instructions. In several cases, it appeared that the applicator had thought that if a little pesticide was good, then a lot must be great. Noticeable nuisance odors could be detected at several of these locations. We did not determine if these odors could cause physical harm to the building occupants but it was apparent that the detection of odors did generate a psychological or emotional reaction in some occupants.

The maintenance staff was observed applying pesticides inside the high school that were labeled for outdoor application only. Again, the applicator had either not fully reviewed the pesticide label or had ignored the application instructions. We did not determine if these applications had caused physical harm to the building occupants, however the physical and chemical qualities of the product suggested that the material would persist in the building and would not quickly dissipate. As a result, it is possible that some occupants may have been exposed to elevated concentrations of this pesticide.

In addition, we noted that some of the faculty and maintenance staff did not consider pesticides to be toxic or potentially harmful substances. This was especially true if the material in question was a common consumer item. The potential household use of the product appeared to de-toxify the material in the eyes of the user. Unfortunately, the health and safety evaluations provided by the manufacturer indicate that this is not a valid opinion.

A final and continuing observation is the failure to post all the necessary state notifications prior to and after all pesticide applications within the schools. This appears to be a common problem in most public and private buildings not just our local schools. In general, there appear to be three routine causes for this oversight: ignorance of the requirement which you would not expect from a licensed applicator, oversight of or disregard for the requirement, or an intentional avoidance of posting the notification in order to not trigger an emotional response from building occupants opposed to pesticide application.

IV. Problems or concerns noted:

- Potential adverse impact on air quality resulting in exposures to staff and students as a result of the misapplication of pesticides inside the high school.
- The application of pesticides by untrained and unlicensed applicators.
- The health risk to staff applying pesticides without using personal protective equipment.

V. Actions taken:

A. Removed pesticides from classrooms and offices.

Pesticide containers have been removed from the classrooms and offices in order to prevent the over application of materials by an over zealous faculty member. In addition, greater emphasis has been placed on identifying the cause of infestations as a means to remove or eliminate the cause of the problem. In most cases, improved housekeeping and food handling enabled us to decrease the on set of ant problems.

B. Disposed of pesticide inventory and contracted with a licensed applicator for pest management services.

After a lengthy review of the state requirements, the school maintenance department decided against having a staff member trained and licensed to apply pesticides. The maintenance department chose instead to contract with a licensed pest management firm to conduct all applications at local schools. In addition, once it had been decided that an outside vendor would be responsible for pest management at local schools, all pesticides were removed from the school department chemical inventory for disposal.

Lessons learned:

The following is a summary of significant lessons I noted during my investigation of pesticide usage at the Burlington public school system.

1. ***The instructions and warnings on the pesticide label are commonly ignored.***

2. ***It is not unusual for inexperienced applicators to believe that if a little pesticide is good then more is better.*** What the applicators did not realize was that certain quantities or doses are safe and once you go above a specified level you can cause yourself harm.

3. ***Many people consider consumer use or household products to be non-toxic.*** If I can buy this product at the local supermarket to use at home then it must be safe regardless of how I use it. Again, the dose makes the poison.

4. ***Actual or threatened exposure to pesticides is a psychological trigger for many individuals.*** Whether real or imagined many people respond physically, mentally or emotionally to the report of possible exposure to pesticides. This manifestation may be good cause for seeking an alternative means for addressing a pest infestation as well as searching for the root cause of the problem.

Tips and suggestions:

1. ***Review state and local pesticide regulations.*** In most cases, state and possibly local pesticide applicator licensing and notification requirements will far exceed federal requirements. Also, due to the variability between states and/or municipalities, it is imperative that you learn what the appropriate requirements are for your jurisdiction.

2. ***Review and evaluate non or less toxic alternatives.*** Pesticide manufacturers have responded to consumer concerns and have developed a number of more benign alternatives to pest control. A classic example is the use of Bti, a bacteria, to control mosquito populations. In this case, the benefits are that a) the biological control method is only harmful to mosquitoes and several other types of insects, b) will not bioaccumulate,

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c) is not harmful to man or animals, and d) does not persist in the environment. Less toxic options now exist. Look for them.

3. ***Develop and implement an integrated pest management plan.*** Rather than simply looking at the bugs and deciding you need to kill them, consider what may have prompted the infestation (housekeeping). Is there anything else you can do to correct, minimize or eliminate these problems? If not, are there non or less toxic alternatives for addressing the problem. Also, is the pest really a problem? So what if you have a couple of dandelions in your lawn. Do you really want to repeatedly expose the kids playing on the grass to herbicides or insecticides? Or do you want to risk contaminating the well used by the school or one of its neighbors by repeatedly applying pesticides and herbicides during landscaping? These are issues that must be evaluated in consideration of local conditions.

Resources:

During this investigation, I utilized the resources available via the Massachusetts Department of Food and Agriculture Pesticide Bureau. I also reviewed guidance information prepared by the U.S. Environmental Protection Agency, and the Department of Labor Occupational Safety and Health Administration. Due to regional differences with regard to the application and management of pesticides, I recommend that you consult with your state agricultural, environmental, health, and occupational hygiene offices, and the regional EPA and OSHA offices prior to initiating your review.

The U.S. Department of Agriculture and the pesticide manufacturers are other potential sources of useful information.

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Chemical Management
Asbestos Management
Indoor Air Quality
Pesticide Usage
Mercury Management
Radioactive Materials
Fire Prevention
Pollution Prevention
Hazardous Waste
Formaldehyde
Radon
Chemical Fume Hoods
Eye Washes
Safety Equipment
Hazards By Department
Emergency Response
Ceramic Kilns
Underground Tanks
Classroom Lasers
Sanitary Drains
EHS PRIMER

A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Mercury Management

The Issue:

Mercury has many industrial uses and applications. Upon inspection you will find that it is present in a number of items commonly found in schools. The problem is that most mercury compounds are also toxic and readily absorbed and accumulated by the body. In addition, due to our common use of mercury bearing articles, many individuals have forgotten or assume that elemental mercury and mercury compounds can be highly toxic if mishandled. Some common items often found in schools which contain elemental mercury include: thermometers, barometers, switches, thermostats, flowmeters, lamps, shoes, and laboratory reagents in the science department. Some of the common items found in schools which may contain mercury compounds include: pesticides, paints and stains, laboratory reagents in the science department (e.g. mercuric salts and oxides), batteries, and fluorescent lamps.

Elemental mercury is a volatile toxic heavy metal. Mercury is an unusual metal in that it can evaporate at room temperature. Also, mercury is a neurotoxin which means it can adversely effect the central nervous system. Upon exposure, mercury tends to accumulate quickly in the brain where it tightly binds with the tissue and is released at a very slow rate. In addition, inorganic and organic mercuric compounds are also commonly found in schools. Mercuric compounds can pose the following types of health hazards: toxic to lethal via ingestion or absorption, toxic to the following organs or systems: central nervous system, digestive system, kidney, liver and skin. Many of these materials may also be teratogenic or capable of causing birth defects.

Because mercury and its compounds tend to be readily absorbed and accumulated by the body, it is imperative that we identify potential sources of mercury within the school system as well as potential activities that could result in the release and exposure to these materials. Due to the pervasiveness of mercury and its compounds in the construction of building materials (e.g. thermostats and fluorescent lights) total elimination is not possible. However, the wisest strategy appears to be that of identification and elimination where possible. Where replacement and elimination is not possible, then efforts should be taken to minimize the risk of release of these materials as well as establishing a contingency plan for properly handling any releases that may occur. If proper spill response is not initiated then these materials can pose a long-term health hazard to building occupants. The final component would be establishing policies and procedures for promoting the proper recycling and disposal of

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mercury and its compounds in order to prevent its release to the environment and to promote compliance with state and federal Universal Waste Disposal requirements..

II. The approach taken:

Our initial step was to review the health hazards associated with elemental mercury and mercuric compounds with the staff. Initially much of the staff was either complacent with regard to considering the hazards posed by these materials or had become "comfortable" due to the historic use of the substances. However, after reviewing available health and safety data as well as anecdotal information, the staff generally agreed that they did not wish to become a "Mad Hatter".

Next, the spill response supplies of each school where mercury and/or its compounds were commonly used were inventoried. As a result, we found that the school department staff had not been trained in spill response procedures and that none of the schools were equipped with a mercury spill kit. Initially, there was no local capability to immediately respond to and mitigate a mercury spill.

Then each school was surveyed for elemental mercury, mercuric compounds, and articles containing mercury. Mercury bearing materials were found in all local schools. The widespread use of mercury in building products guaranteed this observation, but we also noted that experiments and demonstrations involving mercury compounds occurred at all local schools. The prevalence of these materials caused us to review where and how the material was present as well as how it was used. Using this information, we devised a plan to eliminate or replace activities that posed a high risk of release and exposure (e.g. passing electric current through an open container of elemental mercury or activities involving the heating of mercuric compounds). We also attempted to identify mercury bearing items that could not be readily replaced but if broken or improperly managed could create a mercury hazard (e.g. fluorescent lights). Management plans have been created for these items to ensure that these materials are properly recycled/disposed and that accidentally released materials are remediated to eliminate the potential creation of long-term health hazards.

III. Observations made:

The most notable observation made was a general awareness that mercury and its compounds were hazardous to your health. Unfortunately, complacency or familiarity tended to allow much of the staff to overlook these hazards and to continue to use the materials. As a result, several of the common demonstrations and experiments utilized by the staff may have placed the students and faculty at risk to mercury exposure. A benefit of the general awareness was that once re-acquainted with the hazards associated with mercury many of the staff were supportive of replacing or removing mercury from the curriculum.

A second observation was that mercury was present in all local schools in a variety of shapes and forms. Elemental mercury and mercuric compounds were used in experiments or demonstrations at all grade levels. In the higher grades, students were occasionally involved with the handling and use of these materials. In addition, mercury bearing materials such as pesticides, paints, and stains were in use throughout the school system. We also noted that some of the students possessed shoes that contained mercury switches which caused their shoes to light up as they walked. As an aside to the case study, many of these shoes have been re-called by the manufacturer due to the potential for these sneakers to release mercury and cause contamination if placed in a washing machine or dryer.

We also noted that the staff had not been advised how to handle a mercury spill and that the school system did not possess spill response materials. As a result, you can only speculate how past releases were handled. Furthermore, we recognized that our capability to respond to a mercury release was severely limited. Therefore, it was possible that a minor mercury spill could create a long-term health hazard if a classroom was not properly decontaminated.

A final observation was that due to the widespread use of mercury in building products, it is not possible to totally remove articles containing mercury from all our local schools. Our approach has been to identify all potential sources of mercury, and to remove/replace what we could and to develop management/disposal practices and spill plans for those items that could not be removed.

IV. Problems or concerns noted:

- Initially the staff was either complacent or unaware of the hazards associated with mercury exposure.
- The school system had not trained or equipped its staff in order to respond to a mercury release. As a result, minor spills could become long-term health hazards.
- Several of the procedures or demonstrations routinely used by the staff posed the risk of vaporizing mercury and releasing the material into the schools.
- Past management activities may have resulted in the release of mercury into the environmental via releases to the sanitary drains and the disposal of mercury bearing items at the local municipal solid waste incinerators.

V. Actions taken:

A. Identified the sources of mercury present in the local schools. Each local school was surveyed in order to identify the type, location, and amount of mercury bearing materials present. This is an ongoing process as we continue to discover additional items that contain mercury. The following is a summary of the items we have identified to date:

containers of elemental mercury	laboratory reagents containing mercury
thermometers	barometers
flowmeters	thermostats
pesticides	mercury lamps (indoor & outdoor lamps)
paints & stains	fluorescent lamps
mercury switches	shoes
batteries	

B. We identified and eliminated high hazard materials. After identifying the types of mercury present in the local schools, we next reviewed the material with regard to: a) its use, b) its potential for release, and c) the availability of a substitute. Using this criteria, we decided to eliminate the use of mercuric compounds from the curriculum and to drastically reduce the volume of elemental mercury maintained by the school system. As a result, we disposed of 10 pounds of elemental mercury and 3 pounds of various mercuric compounds. Also, steps were taken to discontinue demonstrations involving the unsealed electrification of elemental mercury or the intentional benchtop release of this material. In addition, we also felt that mercury thermometers posed a high risk of release and that these implements could be easily replaced by alcohol thermometers with the same degree of accuracy needed for our uses. This step resulted in the collection and disposal of more than 125 mercury thermometers utilized by the school system. We have also initiated a review of the equipment maintained by the school department in order to identify items containing mercury and to determine their status. During this process we identified a several damaged or obsolete devices containing mercury which have since been disposed.

C. We continue to seek to eliminate other items containing mercury where possible. During our survey, we identified a number of building products which contain mercury such as batteries, paints, stains, thermostats, and fluorescent lights. As these items are consumed or replaced we are endeavoring to locate replacements which are either mercury free or contain less mercury. This is a continuing and evolving process.

D. We have established management/disposal practices for mercury containing articles that remain at the local schools. We recognize that a total elimination of mercury containing articles is not currently possible. As a result, we have developed limited spill response capabilities to address the types of releases that may occur. In addition, we have also established an aggressive plan to identify, manage and recycle all remaining items which contain mercury. Since 1996, we have re-cycled all dead fluorescent lamps generated by the school system. We are continuing to expand this effort to capture all materials regulated by state and federal Universal Waste Regulations (batteries, computer components, electric ballast's).

VI. Lessons learned:

1. ***Beware of experiments involving mercury or its compounds.*** Upon review of the laboratory procedures utilized by the faculty, we found several activities that involved either the electrification of the open containers of elemental mercury, or the intentional release of elemental mercury, or the heating of mercuric compounds. Each of these activities could have resulted in the release of mercury to the classroom and the creation of a long-term exposure risk to the occupants if the material was not properly abated. Due to the inherent volatility of elemental mercury combined with the ability of the body to readily absorb and accumulate mercury along with the difficulty associated with properly cleaning up a mercury release, the wisest approach appears to be to minimize one's exposure to this toxic substance.

2. ***Identify and inspect all equipment containing mercury.*** During our review, we found old lamps, a flowmeter, and a damaged barometer containing elemental mercury. The primary concerns associated with the equipment include: a) equipment failure could result in accidental exposure or a release of material, or b) improper disposal of the mercury containing equipment could result in an environmental release of mercury. During our review, we located two mercury lamps that were routinely used by the faculty to provide a comparison of different wavelengths of light. Upon inspection, we noted that the seals on both units were cracked and in poor condition. As a result, it was possible that mercury could slowly evaporate and escape the units over time. The rate of mercury loss may have been accelerated each time the units were turned on and the mercury was heated. The lesson here is know what the equipment contains and what safe guards are required to be maintained in order to safely operate the device.

3. ***Train and equip your staff for mercury releases.*** Unless you totally eliminate mercury from your school, you must train and equip your staff for releases. Otherwise you risk creating a long-term hazard in your building. In December 1997, a mercury release occurred at a school in Keene, New Hampshire. The staff recognized that the release posed a health hazard and attempted to respond to the release. Unfortunately, their response was ill conceived. They used a vacuum cleaner to collect the elemental mercury. This approach enhanced the volatilization of the mercury and increased the total area of the school contaminated by mercury. They turned a small manageable problem into a large and costly exposure incident that required professional assistance to resolve. Plan ahead and be prepared.

4. ***Develop a mercury disposal program.*** It will be a long time before mercury is eliminated from common building components, so develop a mercury recycling/disposal program to prevent the release of mercury to the environment. This will require you to remove batteries, fluorescent lights and other mercury containing items from your solid waste stream. It

is a good thing to do to protect the air you breath and the water you drink and besides it is the law. If these items are disposed of with municipal solid waste then you risk releasing these materials with leachate from local landfills or via the emissions from solid waste incinerators. These requirements are only going to become more stringent over time so be ahead of the learning curve and do it now.

VII. Tips and Suggestions:

1. ***Learn about what items commonly contain mercury.*** Our mercury assessment program has been in progress for approximately three years. This is because we continue to discover additional items that contain mercury. I encourage everyone just starting to take the time to try to identify all the items which contain mercury that may be present in their schools.

2. ***Due to the difficulty in remediating a mercury spill, I recommend that you strongly consider replacing or removing mercury bearing items wherever possible.*** This approach provides a safer and healthier environment while also reducing your regulatory compliance burden as defined by state and federal Universal Waste Regulations. In addition, improper spill mitigation or waste disposal may also create civil liability for your school and its staff.

3. ***Recognize that not all mercury can be removed and establish a plan of action for managing the remaining material.*** You cannot remove everything. So be prepared to clean up a spill involving what is left. Furthermore, establish a procedure to properly dispose of the material when you are finished using it. Most importantly, communicate this information to your staff as a means to ensure that your plans are properly implemented.

4. ***Review and become familiar with mercury exposure standards.*** Know and understand what the hazards are. Inform your staff of these hazards. Breaking and releasing the mercury from two sixteen inch thermometers could cause you to exceed the mercury exposure standard established by the federal Occupational Safety and Health Administration if the material is not properly abated. Small quantities can create large problems if not properly handled.

VIII. Resources:

During this investigation, I utilized the resources available via the U.S. Environmental Protection Agency and the Massachusetts Departments of Environmental Protection, Health , Labor and Industries. I also reviewed guidance information prepared by the U.S. Department of Labor Occupational Safety and Health Administration. Due to regional differences with regard to the management and handling of mercury containing waste, I recommend that you consult with your state environmental, health, and occupational hygiene offices, and the regional EPA and OSHA offices prior to establishing your own mercury management plan.

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Chemical Management
Asbestos Management
Indoor Air Quality
Pesticide Usage
Mercury Management
Radioactive Materials
Fire Prevention
Pollution Prevention
Hazardous Waste
Formaldehyde
Radon
Chemical Fume Hoods
Eye Washes
Safety Equipment
Hazards By Department
Emergency Response
Ceramic Kilns
Underground Tanks
Classroom Lasers
Sanitary Drains
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A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Radioactive Materials

I. The Issue:

The use and application of radioactive materials in both industry and medicine continues to increase over time. As our knowledge and application of these materials expands, there is also an increased need to study and research these materials. But at the same time the common knowledge of the deleterious effects that exposure to these materials can cause has allowed the term radioactive to become a strong trigger word in modern society. There exists a fine line between useful tool and extremely hazardous material when working with radioactive materials. The key is proper handling, shielding, and control to minimize the risk of accidental exposure to the radiation source.

II. The approach taken:

Our review of the radioactive materials maintained by the school department began when a container of thorium nitrate was discovered in one of the high school science classrooms. In response to this discovery, we surveyed the staff to learn if they were using or aware of any other radioactive materials maintained by the science department. The staff reported that they were not aware of any other radioactive materials present at the school.

Almost immediately we recognized that we did not have even a general summary or list of common radioactive materials. Our efforts to locate such information were unsuccessful. In recognition of this short-fall, we obtained the assistance of the radiation safety officer of the local hospital. This individual conducted a radiological survey of the entire science area. During this effort, we located three additional containers of thorium nitrate, a container of uranium tetrachloride which had been used as a paper weight, three unlabeled multi-chambered containers of radioactive powders, and three radioactive rocks in the geology collection. All of these materials were found in open storage in the classrooms.

Due to the hazards associated with the handling of unsealed radioactive sources, we decided to dispose of the materials discovered at the school. Initially, we contacted the federal

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Nuclear Regulatory Commission (NRC) for assistance with this problem. The NRC informed us that because the school was not licensed to handle radioactive materials and because of the small amount of materials involved the school was under the purview of the Massachusetts Radiation Control Program. Once informed of our discovery and concerns, the Massachusetts Radiation Control Program readily agreed to accept and dispose of the radioactive reagents. The high school geology instructor was allowed to assume ownership of the radioactive rocks with the condition that the materials not be stored in the school.

III. Observations made:

First, the staff was not aware that the school department possessed radioactive materials. As a result, the staff was not aware that these materials were openly stored in their classrooms. A chance observation prompted our discovery and investigation into this issue.

A radiological survey of the high school science area enabled us to identify and locate the following radioactive materials present in the classrooms: uranium tetrachloride, three unlabeled multi-chambered containers of various radioactive materials, three containers of thorium nitrate, and several radioactive rocks. None of the reagents were labeled to indicate that the contents were radioactive.

The most serious observation was that aside from the rocks, all sources were unsealed powders and could pose a serious health concern when handled or if spilled. Normally, sealed radiation sources are used in educational settings for demonstration purposes. A sealed source is created by sealing or embedding a radiation source in a matrix such as plastic. Often by design radiation may only leave the sealed source from one side or location. The intent of this design is to reduce accidental exposure to the source and to prevent the inhalation or ingestion of the source. Since much of the radioactive material found in the science department was powdered there existed the possibility that this material could be inhaled or ingested whenever the material was handled or spilled. As a result, the shielding or protective effect offered by our clothing and skin would be lost if the material entered the body. Also, once in the body these materials would cease to be relatively harmless radioisotopes and could become potentially lethal in nature.

During our investigation, we made no attempt to accurately determine what type of particles or the energy level of the particles emitted by each source. Based on qualitative information gathered during the radiological survey, all sources were presumed to be alpha and beta emitters.

While surveying the equipment maintained by the high school science department we discovered that the department did possess a broken Geiger counter. The presence of this device suggests that radioactive materials may have been used by the staff at some time. No sealed sources were located during the radiological survey or follow up inspections.

A final observation was that the school department was not equipped or trained to monitor for or manage radioactive contamination. As a result, it was not possible to determine if materials or individuals had been contaminated during the past handling of these materials.

Upon discovery of the radioactive materials, the staff was very supportive in having these materials removed and properly disposed.

IV. Problems or concerns noted:

- The staff was unaware of the presence of radioactive materials in the high school science area.
- None of the materials identified during the radiological survey were labeled as radioactive.
- These materials were stored openly in the classrooms.
- All the radioactive reagents were unsealed sources that could be inhaled or ingested when handled or spilled.
- The school was not equipped or trained to monitor for radioactive contamination.

V. Actions taken:

A. Surveyed the science department for radioactive materials.

After a chance discovery of a radioactive material in the high school science department, we surveyed the staff to determine if they were aware of any other radioactive materials that were present in the school. The staff was not aware of any other radioactive materials present in the science area. In order to ensure the completeness of our review, we had the radiation safety officer of the local hospital conduct a radiological survey of the science area. Using a screening device, this individual located the following radioactive materials in the science area: a container of uranium tetrachloride, three additional containers of thorium nitrate, three unlabeled containers of various radioactive powders, and several radioactive rocks.

B. Due to the health hazards associated with the use and handling of unsealed radioactive sources, we arranged for the proper disposal of the radioactive materials.

Once informed of our discovery and concern, the Massachusetts Radiation Control Program agreed to accept and properly dispose of the radioactive reagents we found in the high school science area. A geology instructor requested and was granted ownership of the radioactive rocks found in the school.

Lessons learned:

1. ***Not all radioactive materials are labeled to indicate that they are radioactive, especially if the materials were acquired in the distant past.***

None of our materials were labeled to indicate that the contents were radioactive. Therefore, you cannot assume that the container labeling will provide adequate warning for this hazard.

2. ***Unsealed sources pose serious health hazards.***

Unsealed or powdered radioactive sources pose serious health hazards because these materials can be easily ingested or inhaled if mishandled. Once inside the body even minor or low energy radioactive material can become potentially lethal in nature.

3. ***The presence of Geiger counters, Geiger tubes or scintillation counters may be a strong indication that radioactive materials might be present or have been used at the school.***

The presence of this equipment should be considered as a warning that radioactive material is or has been used at the school. As a result, efforts should be initiated to determine if any sources remain at the school. If sources are found, then efforts should be implemented to determine the activity and energy of the source as well as the health and safety hazards associated with the material. This information will enable you to determine how to safely store and handle the material or whether disposal is the most appropriate option.

Tips and Suggestions:

1. ***Survey the science department staff and review the equipment inventory for indicators which suggest that radioactive materials may be present at the school.***

2. ***Review your chemical inventory for common radioactive materials.***

3. ***Conduct a screening survey of the science department to locate unidentified radioactives.***

Use a radiological screening device to attempt to identify and locate radioactive materials present in the school. Expert assistance in conducting this type of review may be obtained from a local hospital, a local hazardous materials response team, utilities, and state public health agencies.

Resources:

During this investigation, I utilized the resources available via the Massachusetts Department of Pubic Health - Radiation Control Program. I also reviewed guidance information prepared by the U.S. Department of Labor Occupational Safety and Health Administration. Due to regional differences with regard to the management and handling of radioactive materials, I recommend that you consult with your state environmental, health, and occupational hygiene offices, and the regional EPA and OSHA offices prior to initiating your own radiation survey.

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A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Fire Prevention

I. The Issue:

While conducting our environmental, health and safety assessment of the local schools, we identified a variety of fire safety issues and concerns. We have not initiated a standardized or regimented review of each school specifically looking for fire safety concerns. Instead, we have endeavored to resolve the problems as each was noted and identified. The following is a summary of the concerns we have noted to date as well as the corrective action suggested or implemented. During the course of these activities we have relied upon the fire prevention guidance prepared by the National Fire Protection Association (NFPA), the federal Occupational Safety and Health Administration (OSHA), and the Massachusetts Fire Marshall's Office.

II. Observations made:

System wide concerns:

1. We noted that a great deal of confusion existed regarding who was responsible for inspecting and maintaining fire extinguishers. As a result, we found that a number of the units were missing or had not been inspected or re-charged in several years. Standard guidance recommends or requires that all portable fire extinguishers be inspected and maintained at least annually.

2. Another problem noted involving fire extinguishers was that access to a number of these units was restricted by the placement of equipment or material in front of the device. As a result, some of the units were either concealed or virtually impossible to reach in the event of an emergency. Standard guidance recommends or requires that access be maintained at all times to all portable fire extinguishers. This is commonly interpreted to mean a clear and unobstructed path of approximately 2 to 3 feet in width. A sign or symbol should also be posted above the unit to indicate the presence of the unit. In addition, each extinguisher should be mounted at approximately three above the ground.

3. While reviewing the fire extinguishers present in the local schools, we also noted that a number of the units were not rated and approved for the types of fires that could occur in that particular area. This suggested the need for purchasing and maintaining multi-faceted fire extinguishers capable for use against a broad variety of fires.

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4. A significant oversight noted was that none of the staff reported that they had ever been trained in the proper use and operation of a fire extinguisher. Standard guidance suggests or requires that all potential operators be provided with initial and annual refresher training in the use and operation of portable fire extinguishers. We have recommended that the School Department identify staff members with the greatest risk of needing to use an extinguisher and that these individuals be provided with the necessary training.

5. Fire safety concerns were noted at all schools with regard to the storage and maintenance of hazardous materials. These problems were related to 1) the storage of flammable and combustible materials in close proximity to an ignition source, 2) the joint storage of incompatible materials which if combined could spontaneously combust or explode, 3) the storage of open containers of flammable and combustible liquids, and 4) the bulk storage of large quantities of flammable or combustible materials without the use of flammable storage cabinets or comparable protective measures. A review of the chemical inventory present at the schools commonly indicated that many of the flammable and combustible materials were either obsolete or could be readily consumed somewhere within the school system. As a result, improved chemical management and inventory consolidation enabled us to reduce a number of these problems at minimal cost. The conversion from petroleum based cleaning and maintenance materials to water based materials also significantly reduced the volume of flammable and combustible materials present at local schools.

6. Another significant fire safety concern has been the accumulation and long term storage of a variety of paper, wood, cardboard and other combustible materials. In many areas these materials are stacked from the floor to the ceiling. The presence of these materials represents a large volume of fuel should a fire occur at the schools. Improved housekeeping and materials management could alleviate the risk posed by these materials.

7. Another safety hazard noted has been the use of equipment with damaged electrical cords and the possible overloading of electrical circuits caused the increased use of electrical equipment. These observations suggest that an electrical short could cause a fire to occur.

Facilities Maintenance Department:

The department maintains a central supply warehouse at the local high school. All school department supplies are stored and maintained in bulk quantities at this location prior to being distributed to the local schools. Inspections of this storage area have resulted in the following observations.

1. More than 350 gallon of methanol based duplicating fluid were found stored in this area. Methanol is a class A flammable which means that it is as flammable as gasoline. The material was stored in metal 1-gallon containers without the use of any additional fire protection. NFPA and

OSHA guidance recommends that if you maintain more than 60 gallons of a class A flammable then the material should be stored in an approved double walled flammable storage cabinet or comparable fire resistant structure. A review of our consumption of the material indicated that our inventory represented at least an 85 year supply for a declining technology. We reduced the fire hazard posed by this material by reducing our inventory to 50 gallons.

2. Another issue noted was the commingled storage of incompatible materials throughout the warehouse. Materials have been historically stored wherever space was available when the item arrived. A chemical fire in this area in 1991, which resulted in the mixing of bleach, ammonia, and sulfuric acid based drain cleaner, clearly identified the potential problems associated with this practice. However, neither the $500,000 cost of that hazardous materials incident nor the completion of additional hazardous materials handling training has been able to provide the motivation or incentive to modify the departmental storage practices so that some consideration is given to storing materials by hazard category. A lesson that could be taken from industry is that many businesses are now delegating the responsibility and liability for bulk chemical storage to their suppliers by keeping their chemical inventory to a bear minimum and ordering materials as they are consumed. This practice offers the most efficient and cost effective means for safely managing a chemical inventory while also reducing the risk of overstocking materials that may need to be disposed of as hazardous waste at some future date. This could be another useful approach for minimizing the hazards posed by a chemical inventory.

3. Initially, many of the cleaning and maintenance supplies present in the chemical inventory were petroleum based materials. As a result, most of these materials were either flammable or combustible. We reduced this hazard by consuming these materials and by replacing them with water based substitutes which were none flammable. An additional benefit of this approach was that the replacement materials generated fewer emissions when used and as a result had less of an impact on indoor air quality in comparison to the original products.

4. Another problem noted was that access to fire extinguishers is routinely obstructed by the placement of goods and materials during warehouse activities. This continues to be a housekeeping issue. The creation of areas where materials storage was not allowed and the placement of fire extinguishers in these areas could help to alleviate this problem.

High School Science Department:

1. A significant fire hazard noted in the High School science area was the open storage of a large volume of flammable, combustible, and peroxide forming (potentially explosive) materials in the classrooms and laboratories. This problem was compounded further by the joint storage of oxidizers, corrosives and other reactives with these materials. As a

result, accidental mixing of incompatible materials could easily have occurred and resulted in a fire or explosion. Even if the concern for the incompatible materials was ignored, the sheer volume of flammable and combustible chemicals posed a fire safety concern. We have addressed these problems by significantly reducing the size of the chemical inventory, and by eliminating and disposing of many of the extremely hazardous or obsolete materials. We have also improved chemical storage by removing the chemicals from the individual classrooms and laboratories, and consolidating these materials based on hazard class within a re-enforced chemical storage locker and several double-walled chemical storage cabinets.

2. An oversight noted during our review was that the school department did not possess a class D fire extinguisher for use against fires involving burning metals. Due to the continued use of combustible metals in the local curriculum, we have recommended that the science department be equipped with at least one class D extinguisher.

3. The science area has been constructed with a re-enforced chemical storage locker or closet for the bulk storage of the chemical inventory maintained by the department. This area has been equipped with a fire suppression system. Unfortunately, during our review we noted that the fire suppression system had not been routinely inspected and serviced to ensure its proper function. We have recommended that this system be inspected and tested on at least an annual basis.

4. A review of the science area determined that nearly all of the rooms in this area are constructed with gas jets. We have noted concerns regarding the possibility that a prankster could turn on the gas jets in an unoccupied room and thus create a serious fire or explosion hazard in the school. We also noted that each room is equipped with a main gas shut off. We have recommended that the gas be shut off and locked out when not in use as a means to prevent the accidental release of natural gas in these areas.

High School Art Department:

1. The presence of flammable solvents in the art department poses a fire hazard. Fortunately, the department maintains only a small amount of these materials on hand at any given time. In addition, these materials are stored in a cabinet designed for the storage of flammables when not in use. As a result, the proper use and management of these materials have been effective in mitigating the hazard posed by these materials.

2. We have also noted concerns related to the possibility of electrical short circuiting associated with computer graphics equipment and kilns maintained by the department. Our concern is that the electrical wiring provided in this area was not designed and constructed in consideration of the possible use of this type of equipment. As a result, there is concern that the system may be overloaded and result in a fire. The school department is currently having a licensed electrician review these issues.

Home Economics:

A review of the exhaust fans used by the Home Economics classes has found that a number of these units are clogged with grease. The presence of grease increases the likelihood that one of these units could catch fire. The implementation of a routine maintenance and cleaning plan has alleviated the risk of a fire involving these units.

III. Resources:

When reviewing these issues, I relied heavily on the information and assistance offered by the National Fire Protection Association, the federal Occupational Safety and Health Administration and the Massachusetts Fire Marshall's Office. Each agency offered a broad variety of information related to the use and maintenance of fire extinguishers, the proper storage of chemical materials, and the identification and correction of electrical hazards.

They can all be contacted via the internet.

National Fire Protection Association	http://www.nfpa.org
Occupational Safety and Health Administration	http://www.osha.gov
Massachusetts Fire Marshall's Office	http://www.Magnet.state.ma.us/sfmo/sfmohome.htm

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ERIC

A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Pollution Prevention

I. The Issue:

In this section I have provided an outline and summary of the pollution prevention initiatives that have been implemented within the Burlington public school system. Pollution Prevention or P2 is an organized effort to prevent the release of hazardous materials to the environment. During this process, we have noted that use of these practices has resulted in the following benefits: 1) a reduction in hazardous indoor air emissions which has enabled us to improve indoor air quality, 2) improved chemical management and safety, 3) improved chemical recycling and disposal practices which have decreased the likelihood of a release to the environment, 4) improved health and safety of the building occupants, and 5) a reduction in the chemical inventory maintained by the school department. Many of the practices we implemented were initiated with either little or no additional cost. In most cases, the change was related to the following: improved operation and maintenance practices, chemical substitution, or process modification (experimental re-design). Any school system could easily adopt our approach.

II. Pollution Prevention Initiatives:

The following is a general list and summary of the P2 activities implemented by the Burlington public school system.

1. A detailed chemical inventory has been prepared by all schools and departments within the system. This step enabled us to identify what materials we had, and where and how these materials were stored. As a result of this exercise, we quickly learned the true size of our inventory and the full extent of redundancy and overstocking in our inventory. We also determined that chemicals were stored inappropriately in the classrooms of all local schools. This information made it possible for us to: a) consolidate our chemical inventory, b) identify potentially hazardous storage activities, and c) identify inefficient purchasing practices.

2. Once the size and nature of the chemical inventory was determined, we made an effort to consolidate the materials. This allowed us to quickly identify obsolete materials no longer used by

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the staff. In addition, we were also able to identify a large amount of redundancy and overstocking of materials where different teachers or departments had purchased the same material without checking to determine if the material was already available. As a result, we were able to identify and designate obsolete and excess material for disposal. Furthermore, we were able to modify and improve our chemical storage and purchasing practices to alleviate the risk of acquiring additional amounts of a material that was already present within the school system.

3. While consolidating the inventory, the staff identified a number of materials that were no longer used or obviously degraded and no longer useful. As a result, we were able to reduce our chemical inventory further. This enhanced the health and safety of the building occupants. An added benefit of the chemical inventory consolidation was that as we reduced the size of the inventory we found it easier to provide safe and effective storage for the materials we retained.

4. As part of our consolidation, we reviewed the hazards associated with the materials in our inventory. As a guide, the School Committee adopted formal policies prohibiting the storage and use of carcinogens as well as materials capable of causing genetic damage or birth defects by students. The School Committee also banned the use or generation of material with a hazard rating of 4 as established by the National Fire Protection Association (NFPA). The NFPA has developed a 0 (no hazard) to 4 (highest hazard) ranking for hazardous materials for use by firefighters and other emergency responders. Using this guide, the staff culled the chemical inventory further.

5. The consolidation of the chemical inventory clearly indicated that improvements in the purchasing and management of materials were needed. Repeatedly, we found large containers of the same materials scattered throughout the school system. In a number of cases the containers had never been opened. In order to prevent the re-acquisition of banned materials or chemical overstocking, the school system adopted new chemical purchasing procedures. Each department chairman is now required to review and approve all chemical purchases. The chairman is responsible for reviewing the hazards associated with the material as well as whether the material available elsewhere in the department.

6. Many of the high hazard materials found in the high school science department were found to have been obtained as the result of chemical donations given to the school by local businesses. As a result, the science department had become a means of hazardous waste disposal for local industry. The termination of this practice helped to reduce the volume and toxicity of new materials entering the science department each year. An aside, is that this practice also created a regulatory and storage nightmare for the school because few of the substances were transferred with a copy of their

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material safety data sheet and consequently the staff was unaware of the hazards associated with the materials.

7. Another observation noted was the 'use it or lose it' purchasing mentality. Much of the staff feels compelled to annually exhaust their budget designated for chemical purchases regardless of whether new materials are needed. This system promotes overstocking and inventory expansion. A sustained effort must be initiated to break or curb this habit.

8. We also trained the staff with regard to the hazards associated with the materials they were routinely using. The hope was that by providing the faculty with a clear understanding of the potential health and safety issues present in their work place, they would now be motivated to look for more benign substitutes. As part of this effort, we also discussed how staff activities could impact indoor air quality and how these actions could be altered to decrease the potential impact. The success of this approach has been limited by a pervasive resistance to change.

9. A review of the hazardous waste disposal practices indicated that few formal policies or procedures existed. Historically, hazardous waste disposal has been at the discretion of each staff member. We adopted formal waste management procedures for the entire school system and established a central hazardous waste storage area in order to provide for secure storage located away from the classrooms. Simple improvements in policies and procedures has significantly enhanced our ability to properly and safely manage chemical waste while also decreasing the risk of an adverse environmental impact.

10. Training has been a major component of our new waste management program. The staff have been trained staff with regard to waste management issues associated with their department as well as informed of local prohibition regarding chemical disposal via the local sewer and the management of universal waste. The intent of this program is to have each faculty member think twice before simply discarding something in a trash can.

11. Efforts have also been initiated to promote the use and adoption of non-toxic chemical substitutes. This can be accomplished by simple one to one substitutions such as latex paint for oil based paint or through process modification or experimental re-design. The individual motivations of each teacher appear to be the key for this effort to be successful.

12. Another initiative has been the introduction and use of microscaling by the science staff. Microscaling is a process where an experiment is re-designed so that 1/10 or less of the original amounts of the reagents are now used in the procedure. As a

result, less chemistry is used, fewer emissions and waste are generated, and safety is enhanced. Another benefit is that students and staff members learn to be more precise in their handling of chemicals. A potential drawback may be the need to obtain new laboratory glassware.

III. Lessons Learned:

1. *Do not overwhelm yourself.* Attempt to address each problem area as you identify it rather than looking for an all encompassing cure all. Also, this approach allows you to make small readily achievable gains. Use these small gains to build up your success with the ultimate goal of establishing a comprehensive pollution prevention and regulatory compliance program.

2. *Be creative and open minded.* This can be especially important when attempting to re-design experiments or lesson plans. We have found that many solutions exist for decreasing the toxicity of a curriculum. It is important to find one that meets the needs and constraints of your staff and school system.

3. *Old habits die hard.* Additional motivation may be necessary in order to insure the implementation and use of pollution prevention techniques at your school.

4. *In most cases, the adoption or implementation of pollution prevention techniques has enabled the town to realize a cost savings and/or a reduction in long term liability.* These benefits can provide strong arguments for expanding these efforts.

IV. Resources:

I have found the following resources to be invaluable when researching pollution prevention measures to be implemented at the local schools.

Massachusetts Office of Technical Assistance
Attn: Lisa Dufresne
100 Cambridge Street, Room 2109
Boston, Massachusetts 02202
Telephone: (617)727-3260
Fax: (617)-727-3827

This agency provides free, non-regulatory technical assistance to schools located in the Commonwealth of Massachusetts. This agency also maintains a large database of technical information describing the investigation and resolution of a broad variety of potential environmental, health and safety issues that are commonly found in schools.

Dr. Mono M. Singh, Director
The National Microscale Chemistry Center
315 Turnpike Street
Merrimack College
North Andover, Massachusetts 01845
Telephone: (978)837-5137
Fax: (978)837-5017
e-mail at msingh@merrimack.edu.

The National Microscale Center at Merrimack College has prepared guidance describing the benefits as well as how to initiate a microscale science curriculum. The center also conducts training for those wishing to develop a microscale program.

Center for Safety in the Arts
5 Beekman Street, Suite 820
New York, New York 10038
(212)227-6220

The Center for Safety in the Arts monitors and evaluates a broad range of health and safety concerns involving the arts and theater. This group has also published a large volume of health and safety guidance. They also offer a variety pollution prevention information.

Maryland Department of Education
Office of Administration and Finance
Office of School Facilities
200 West Baltimore Street
Baltimore, Maryland 21201

The Maryland Department of Education has published a number of helpful technical bulletins describing potential EHS issues in schools as well as potential corrective action.

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Chemical Management
Asbestos Management
Indoor Air Quality
Pesticide Usage
Mercury Management
Radioactive Materials
Fire Prevention
Pollution Prevention
Hazardous Waste
Formaldehyde
Radon
Chemical Fume Hoods
Eye Washes
Safety Equipment
Hazards By Department
Emergency Response
Ceramic Kilns
Underground Tanks
Classroom Lasers
Sanitary Drains
EHS PRIMER

A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Hazardous Waste Management

I. The Issue:

The proper management of hazardous materials and waste is necessary to promote occupational safety and to prevent environmental degradation. Unfortunately, the issue is frequently left to chance in many local schools. As a result, students and faculty are routinely placed at risk by dangerous storage and handling practices, and often times hazardous chemicals are released to the environment via improper disposal to sanitary drains or as solid waste. Many of these problems can be readily resolved by educating your students and staff so that they can identify hazardous materials which require special handling and disposal. In addition, each school system should establish a standardized set of procedures for coordinating the collection and disposal of hazardous waste generated by all departments within the school district. As part of this effort, the school system should also review and investigate methods available for reducing or eliminating the generation of waste in the first place. The following is a discussion of the steps taken to improve hazardous waste management within the Burlington school system.

II. The approach taken:

Our effort began with a comprehensive assessment of the chemical inventories maintained by each section of the school system as well as the waste streams generated by their activities. This enabled us to determine the types and volume of waste being generated by the school system. At the same time, we also made efforts to learn how the school department had historically managed these materials.

Based on this initial analysis, we noted a general lack of staff knowledge with regard to the needs and requirements associated with hazardous waste management. We also determined that hazardous waste could potentially be generated by nearly all divisions of the school system. Most importantly, we realized that the school department did not have a standardized and consistent method for identifying, consolidating and properly disposing of its hazardous waste.

In response, a centralized hazardous waste collection program was adopted by the school department along with procedures promoting the safe and proper disposal of these materials. As part of this effort, a central secured hazardous waste storage area was established to promote the consolidation and storage of these items outside the areas frequented by the students. In addition, we provided the staff with training in terms of how to identify potentially hazardous waste as well as a description of safe and appropriate methods of disposal.

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III. Observations made:

Records indicate that the high school science department may have routinely disposed of their chemical waste via the sanitary sewers. In 1971, the science department sought information from local agencies describing the local sewer system with the purpose of optimizing the dilution of materials they discharged via the sanitary sewer system. In 1986, an explosion occurred at Burlington High School when aluminum phosphide, a water reactive material, was discarded via a lab sink. This explosion damaged the sanitary drains and a cinder block wall at the school. In addition, poisonous phosgene gas was generated by this reaction and released into the school.

During our review, we were unable to locate any records which indicated how the school department disposed of hazardous waste prior to 1991. Part of this problem is related to poor records management, but a portion of the problem was that chemical wastes were not routinely managed in a controlled manner.

Initial surveys of the staff indicated that many had a limited understanding of the health and safety concerns, and regulatory requirements associated with hazardous waste management. As a result, past hazardous waste management activities may have impacted indoor air quality and occupant safety, or resulted in an environmental release.

Another observation was that the school department did not have standardized disposal procedures or guidance for staff use. Chemical disposal was left to individual interpretation and initiative, consequently, a variety of methods were used by the staff to manage the chemical waste generated by the school system. The development of a standardized hazardous waste management plan assisted our efforts to consolidate and safely dispose of the chemical wastes generated by the school department.

The completion of a comprehensive chemical review allowed us to consolidate and coordinate the disposal of similar waste streams. This approach allowed us to increase the efficiency of our chemical disposal activities and to reap additional cost savings by improving the efficiency of our waste disposal activities.

A complimentary process has been the slow conversion to less or non-toxic alternatives along with increased chemical recycling and the adoption of microscale science programs. The implementation of these practices has enabled us to reduce our waste streams. In addition, this approach has improved the health and safety of school occupants, enhanced indoor air quality, decreased chemical disposal costs, and decreased long term liability for the town.

IV. Problems or concerns noted:

- Existing information suggests that the school department may have inappropriately managed their chemical wastes prior to 1991.
- A lack of guidance and training may have prompted the staff to develop and utilize a variety of creative and questionable disposal practices.
- The lack of hazardous waste disposal guidance also prompted some staff members to store and accumulate hazardous waste in their classrooms.
- In addition to chemical wastes, many other classroom items may need to be properly managed or recycled due to potentially hazardous components (e.g. fluorescent lights, computer components, ballast's and capacitors, mercury switches). This needs to be considered before obsolete equipment is discarded.
- The failure to coordinate waste disposal activities resulted in the issuance of multiple generator identification numbers to the school department. This could have resulted in a variety of compliance problems for the school district.

V. Actions taken:

A. Evaluated existing waste disposal practices and developed new hazardous waste disposal practices. Historically, hazardous waste disposal had been left to the creativity and initiative of each individual staff member. As a result, many by-products were either managed inappropriately or were accumulated within the local schools. We resolved this problem by developing a centrally coordinated hazardous waste disposal plan. Our approach requires each department to identify and properly collect and label their hazardous waste. Where possible these materials are temporarily stored in a secure satellite hazardous waste storage area located within each department or school. Then at periodic intervals these materials are re-located to a central hazardous waste storage area in the high school which is located away from the areas frequented by the students. Hazardous wastes are immediately transported to the central storage area for those departments where temporary storage is not possible. This approach has improved our ability to properly dispose of the hazardous waste generated by the school department in a safe and cost effective manner. This method has also enable us to establish departmental responsibilities as well as identify potential problem areas.

B. We trained the staff with regard to the need to and method for managing hazardous waste. During our evaluation, we found that the staff had a limited understanding in terms of what was a hazardous waste and how and why it should be managed. We provided the staff with training in how to identify and manage their wastes. As a compliment to these efforts, we have also promoted the adoption of non-toxic or less toxic alternatives as a means to reduce the volume or toxicity of the waste generated by the school department.

C. We established a central hazardous waste storage area. We have designated a secure storage area located away from the student population as a hazardous waste accumulation area. This approach enables us to coordinate the consolidation and efficient disposal of all the waste streams generated by the school system. We have also been able to improve school health and safety by reducing the risk of accidental contact with the materials while also reducing the potential impact on indoor air quality.

D. We have incorporated the management of universal wastes with our hazardous waste disposal program. As required by state and federal regulation, we have included the management of all universal wastes (e.g. fluorescent lights, ballast's and capacitors, mercury switches, computer components) with our routine hazardous waste disposal activities. This approach will enhance our ability to promote regulatory compliance and decrease the risk of a release to the environment.

Lessons learned:

1. ***If you don't provide the staff with guidance describing how to identify and manage their hazardous waste then they will develop their own methods.*** The creativity and ingenuity of the staff may not always be safe or legal.

2. ***We found that hazardous waste is generated at each local school regardless of grade level.*** As a result, your hazardous waste management plan and training efforts must be comprehensive in order to include all materials generated by your local schools.

Tips and suggestions:

1. ***Identify all your waste streams and remember to include universal waste items.***

2. ***Store your hazardous wastes in a secure storage area located away from areas frequented by the student population.***

3. ***Review and inspect obsolete equipment prior to disposal to ensure that it does not contain hazardous components that need to be recycled or disposed of as hazardous waste.*** Potential items of concern include: batteries, ballasts, capacitors, mercury switches, cathode tubes, computer components, and lamps.

4. ***Train and inform your staff of your hazardous waste management procedures.*** Their support and participation is necessary for your efforts to be successful.

5. ***Promote methods to eliminate, conserve or recycle the hazardous materials in your inventory as a means to decrease the volume of hazardous waste generated by your school system.*** This approach can improve the health and safety of your schools while also decreasing your disposal costs.

Resources:

State environmental and public health agencies, and the regional office of the U.S. Environmental Protection Agency are valuable resources when reviewing this issue. Due to regional differences in hazardous waste management requirements, both state and federal agencies should be contacted to determine what requirements apply to your school district. Furthermore, local businesses, universities, and environmental groups may also be able to provide additional support and assistance.

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A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Formaldehyde

I. The Issue:

Formaldehyde is a fungicide and bactericide commonly used to preserve biological specimen. Many middle and high school science curricula utilize preserved biological specimen for demonstration and dissection purposes. The major problems associated with using specimen preserved in formaldehyde is that the material is a confirmed carcinogen as well as a serious respiratory irritant. As a result, active mechanical ventilation is required to prevent the accumulation of potentially dangerous concentrations of formaldehyde vapors. This task is hampered by the fact that formaldehyde vapors are heavier than air and tend to settle near the floor in a classroom or laboratory. This can be extremely problematic in buildings where the ventilation system is mounted on the ceiling or designed for air contaminants that are lighter than air and naturally rise.

II. The Approach Taken:

Routine inspections of the high school science area have often resulted in the detection of formaldehyde odors in the biology labs or nearby classrooms. A survey of the staff indicated that formaldehyde odors were a common nuisance each year when anatomy instruction was taking place.

A review of the biological specimen maintained by school department indicated that most of the preserved specimen owned by the school department had been treated with formaldehyde or a formaldehyde based material. As a result, the handling or dissection of many of these items represented a variety of potential health and safety issues.

A survey of scientific supply vendors determined that a number of less toxic or non-toxic alternatives are readily available. A variety of replacement preservatives and biological specimen free of formaldehyde are available in the market place. Not all substitutes are free of potential hazards, but most have eliminated the potential exposure to a confirmed carcinogen while also reducing the impact on indoor air quality.

Based on the availability of less toxic alternatives, the school department has been encouraged to replace its existing inventory of formaldehyde preserved specimen with newer less hazardous specimen. This approach could significantly improve the indoor air quality within the science area and adjoining classrooms while also reducing the exposure risk of the instructor and students working with the specimen. In addition, the elimination of the use of formaldehyde would decrease the need to

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augment and enhance the ventilation system serving the biology laboratories. Another potential cost savings would be related to a reduction in the amount of hazardous waste that would be generated by the science department and need special treatment or disposal.

Barring the replacement of all formaldehyde preserved specimen with less toxic substitutes, the Board of Health has recommended that all dissections involving formaldehyde preserved specimen be completed only in areas that have been provided with adequate mechanical ventilation capable of eliminating the respiratory hazards created by the formaldehyde. The federal Occupational Safety and Health Administration has placed a high level of importance on minimizing occupational exposure to formaldehyde. Federal regulation 29 CFR 1910.1048 has established 0.5 parts per million (ppm) as an action level where an employer must take action to minimize an employee's exposure to formaldehyde. This regulation has also established a maximum permissible exposure limit for an adult worker over an eight hour day of 0.75 ppm, and a short term exposure limit (15 minutes) of 2 ppm. These exposure standards have been devised for adult workers in an occupational setting and cannot be directly applied to a school setting. However, these standards do provide a metric for comparison. In addition, most industrial hygienists tend to apply a safety factor for children due metabolic and developmental differences between children and adults, and as a result reduce acceptable chemical exposure standards correspondingly. This is significant because the odor threshold or the concentration at which most individuals can smell formaldehyde is 0.8 ppm. This means that in most cases if you can smell formaldehyde then you have exceeded the federal action level and may possibly exceed the exposure limit if you have prolonged exposure to the odor.

The Board of Health has also informed the school department staff of the need to manage dissection waste as hazardous waste due to the formaldehyde content. Our intent was to ensure that all liquid preservatives and bulk quantities of preserved tissues were properly managed to prevent an environmental release of the material.

III. Observations Made:

Staff complaints and follow up inspections have resulted in the detection of formaldehyde odors in the science area and adjacent classrooms at the high school. These observations have coincided with the times when preserved specimen have been used in the biology classes.

Most of the biological specimen used by the school department have been preserved in formaldehyde. This suggests that the open handling and dissection of these samples may pose a potential health and safety risk to the user as well as an indoor air quality concern for the school.

Many classrooms where dissections have historically been conducted have not been provided with adequate mechanical ventilation capable of removing formaldehyde vapors from the school. This re-enforces the need to either re-locate the dissection activities to a different classroom/laboratory equipped with enhanced mechanical ventilation or to adopt a safer alternative. Failure to do so will prolong the risk of occupational exposure to the students and staff while also adversely impacting the indoor air quality of the school.

It was also noted that much of the staff appears to be complacent with regard to the hazards associated with exposure to formaldehyde. Years of handling the material has caused some staff members to assume that the material is relatively non-toxic and the precautionary measures are reactionary in nature. As a result many safety advisories continue to go unheeded.

IV. Problems or Concerns Noted:

- The detection of formaldehyde odors in the high school suggests that the federal health and safety action level may have been routinely exceeded and that permissible exposure limits may have been reached.
- The majority of biological specimen maintained by the school department have been preserved in formaldehyde and therefore represent a potential health and safety concern for the user.
- Much of the staff appears to be complacent with regard to the health and safety concerns associated with formaldehyde exposure and as a result few preventative measures have been implemented.
- The areas where dissections are routinely conducted lack of the mechanical ventilation necessary to properly exhaust the formaldehyde vapors.

V. Actions Taken:

A. Identified the problem and informed the staff of potential hazards.

The initial step was to investigate and determine the source of odor complaints registered by the school department staff and detected during routine inspections. The source of the formaldehyde odors was quickly traced to the biology classrooms. The potential hazards and solutions to this problem were then discussed with the staff in an effort to provide a short term improvement.

B. The inventory of biological specimen were then surveyed to determine the extent of the problem.

This effort found that the majority of the specimen in the school inventory had been preserved in formaldehyde. Consequently, the handling or use of these items poses a potential health and safety concern and may adversely impact indoor air quality.

C. Scientific supply vendors were surveyed regarding the availability of non or less toxic alternatives.

This survey determined that a variety of more benign and environmentally friendly alternatives were readily available.

D. The Board of Health has recommended that the school department replace its inventory of formaldehyde preserved specimen with less hazardous substitutes.

This approach could reduce occupational exposure concerns, improve indoor air quality, alleviate the need to implement costly modifications to the school ventilation system, and may reduce the volume of hazardous waste generated by the school.

E. Pending the adoption of a less toxic alternative, the Board of Health has recommended that all activities involving formaldehyde or preserved specimen be conducted with the aid of adequate mechanical ventilation.

The intent of this directive was to improve and protect the indoor air quality at the school and to reduce the chemical exposure hazard for the user.

F. The school has initiated the collection of all dissection waste for disposal as hazardous waste.

The purpose of this exercise is to prevent the inadvertent release of hazardous materials to the environment.

Lessons Learned:

1. ***If you can smell formaldehyde then you may have exceeded the OSHA action or exposure limits.***

2. ***Less toxic alternatives are readily available.***

3. ***Familiarity with formaldehyde may cause users to become complacent with regard to the health hazards associated with the substance.***

4. ***Many school laboratories have not been constructed with adequate mechanical ventilation capable of properly exhausting formaldehyde vapors from the building.*** This provides a strong incentive for seeking and adopting a less toxic alternative.

Tips and suggestions:

1. ***Train and inform your staff of the hazards associated with formaldehyde exposure.*** This may enable you to identify and develop a supporter who may assist your efforts to mitigate this hazard.

2. ***Replace existing specimen preserved in formaldehyde with less toxic***

specimen. This step may eliminate or at least significantly reduce your health and safety concerns associated with animal dissection and demonstrations.

3. ***Use formaldehyde and formaldehyde preserved specimen only in areas where mechanical ventilation can properly prevent the build up of formaldehyde.*** Failure to do so may result in the accumulation of dangerous concentrations of formaldehyde.

Resources:

During this assessment I relied upon the guidance and assistance offered by the staff of the regional office of the federal Department of Labor Occupational Safety and Health Administration. I encourage you to contact your regional OSHA or state occupational hygiene offices prior to initiating a comparable review.

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A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Radon

I. The Issue:

Radon is a naturally occurring odorless radioactive gas commonly found in association with granite based rock formations. Prolonged inhalation of elevated levels of radon gas may cause lung cancer in humans.

Due to the preponderance of granitic bedrock in Massachusetts, we knew that the evolution of radon gas was likely in Burlington. In addition, while surveying the local schools we observed that each school was constructed with a sandy bottom crawl space rather than a sealed concrete slab or foundation. As a result, there existed the possibility that ledge may be present under the crawl space and that radon could enter the schools via the crawl space and adversely impact the indoor air quality.

II. The approach taken:

In an effort to evaluate for this potential hazard, we screened each school for radon using eight to twelve perforated charcoal sampling canisters which were placed in the school for 48 hours. Half the canisters were placed in the crawl space and half were placed in classrooms. The sampling canisters were placed in areas which were free of moisture, drafts, and were located away from the heating and ventilation system. The canisters were left undisturbed during the 48 hour test period. This strategy was utilized as a means to assess the worst case scenario (crawl space) and actual potential occupational exposure (classroom) in each building. We conducted our tests during the winter heating season when fresh air exchange was minimized and radon concentrations could conceivably build up to their highest levels. In addition, we also wanted to note what effect the heating system may have on pressurizing the building and thereby potentially creating a vacuum which could promote the introduction of radon into the building.

III. Observations made:

Fortunately, the majority of the samples analyzed were below the EPA action level of 4 picoCuries of radon per liter of air (4.0 pCi/L). Elevated concentrations were detected initially at several locations, however re-analysis failed to detect elevated concentrations at these locations. Based on this information there does not appear to be a radon concern at any of the local schools.

One concern we noted is that nearby blasting or construction could

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fracture the local bedrock or a school foundation and create a new pathway for radon migration. As a result, a radon problem could develop at a future date, consequently continued vigilance is required to monitor for this potential problem. Nearby blasting or the discovery of new cracks in the foundation should serve as a warning that additional radon sampling may be necessary.

Tips and suggestions:

1. ***Before beginning a radon assessment, you should review local geological conditions and existing sampling data to determine if radon is known or believed to be a problem in your community.*** State and federal environmental agencies and geological surveys may be able to assist this effort.

2. ***The following potential pathways may make your school susceptible to the introduction of radon: dirt or rock foundation, cracks or holes in the foundation, a sump pump, a drain discharging to a drywell, and well water.*** In addition, if the heating and ventilation system pressurizes the building, then it may be possible for the operation of this system to enhance the introduction of radon into the building via these openings.

3. ***If radon is known to be a potential problem in your area, then efforts should be initiated to seal the obvious potential migration pathways to hinder the ability for radon to enter your school.*** This may be impossible in some areas such as a dirt or stone foundation or crawl space. If elevated radon concentrations are detected then additional ventilation may be required for the locations which cannot be easily sealed.

4. ***Radon testing should be conducted under the worst case scenario when the building is sealed and fresh air exchange is minimized.*** The introduction of fresh air via drafts or the ventilation system may lower the radon concentrations and cause you not to detect the highest concentration present in the building.

5. ***Before initiating expensive remedial measures, re-sample to confirm that elevated concentrations do exist.*** Sampling errors can occur. Don't compound one error with a more expensive one. Also, check to make sure that another radioactive source is not present in the test area, especially if you are sampling a science classroom or ceramics studio where radioactive materials may be present.

6. Remember to monitor local development because nearby blasting and construction may cause new fractures in your foundation or bedrock and create a new pathway for radon to enter your school. As a result, periodic testing may be required if development is occurring in the vicinity of your school.

Resources:

I utilized the guidance and resources offered by the Massachusetts

Departments of Environmental Protection, and Public Health, the U.S. Environmental Protection Agency, and the U.S. Geological Survey to assist with the completion of our evaluation. Due to the regional differences in geology and building construction, I encourage you to contact your state environmental and public health agencies in addition to your regional EPA and USGS offices for a more accurate description of the conditions and concerns of your area. In addition, these agencies have prepared a wealth of information describing the hazards associated with radon as well as how to screen for and resolve problems associated with the build up of radon gas.

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A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Chemical Fume Hoods

I. The Issue:

Many of the experiments and demonstrations routinely conducted as part of the standard high school science curriculum often involve volatile substances, the heating of materials, or reactions which may result in the evolution of gases or odors. As a result, these activities may release materials that could adversely impact indoor air quality and create a health hazard for the occupants. In addition, it may not be possible to totally eliminate and replace all the activities and materials which generate nuisance or hazardous emissions with totally benign replacements, consequently there exists a need to provide enhanced mechanical ventilation in these classrooms in order to properly evacuate these contaminants. Failure to adequately ventilate these classrooms may enable contaminants to build up to hazardous concentrations in these areas. Furthermore, improper ventilation of these rooms could cause these contaminants to enter the building heating and ventilation system and place the entire school population at risk as the materials are distributed throughout the building. Therefore, it is imperative that each chemical procedure be reviewed for potential impacts on indoor air quality. Where possible alternatives should be sought which do not generate hazardous emissions or which generate fewer or less toxic emissions. For those circumstances where no alternatives exist, safe and proper mechanical ventilation must be provided to remove the contaminants from the building as a means to maintain the health and safety of the occupants.

II. The approach taken:

An initial component of our survey was to review the activities occurring in each of the high school science classrooms as a means to evaluate whether these activities could adversely impact indoor air quality. During this effort, we determined that potentially hazardous activities requiring additional mechanical ventilation were occurring in most of the classrooms utilized by the science department. Please note that additional mechanical ventilation may also be needed in middle school science areas as well as secondary level art studios.

Next, a survey of the classrooms used by the high school science staff indicated that less than 40% of these rooms were equipped with chemical fume hoods. In addition, we found that none of the middle school science rooms or the secondary level art studios had been equipped with chemical fume hoods to provide additional mechanical exhaust. As a result, the construction of the individual classrooms limited what activities or materials could be safely used by the occupants without jeopardizing indoor air quality.

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Our next step was to have the existing hoods inspected and re-calibrated to ensure that the units functioned properly. The initial use and reliance on inexperienced and unqualified repair personnel caused this task to be time consuming and difficult to resolve. We utilized three contractors over a period of more than four years before we were able to fully assess, repair, and re-calibrate our hoods. The problems we encountered highlight the need to utilize experienced and knowledgeable ventilation specialists from the start.

Once all the fume hoods have been repaired and re-calibrated, we intend to provide the staff with additional training which outlines how the units should be used in order to promote the safe and proper operation of the hood. Furthermore, a preventative maintenance and re-calibration schedule will be established for each unit. As part of this routine, each hood will be tested and re-calibrated at least once annually by a trained professional. All hoods found to be malfunctioning or out of calibration will be immediately removed from service until the unit has been repaired.

III. Observations made:

During this evaluation, we noted that the existing chemical fume hoods were not routinely used for their intended purpose but were instead used for the storage of equipment or chemicals. In addition, almost all activities involving the use of volatile materials or resulting in the generation of fumes, vapors or odors were conducted at bench top without the aid of additional mechanical ventilation. As a result, these activities may have adversely impacted the indoor air quality in the effected areas.

We also observed that the staff used the hoods to evaporate unwanted reagents or experimental byproducts as a means to reduce or consolidate laboratory waste. State and federal hazardous waste management regulation consider this improper and illegal waste treatment. Therefore, you should not copy this practice because you would be promoting the introduction of contaminants into the atmosphere and the local environment.

Our survey also found that neither the staff nor the students had been provided with guidance in terms of how to safely operate the hoods or what activities and uses were considered appropriate and acceptable. As a result, the hoods were rarely operated in a manner to maximize the effectiveness of the unit and the safety of the operator.

During our inspection, we noted that most of the fume hoods were in a state of serious disrepair. We found units that were missing interior panels and covers and as a result leaked contaminants. We found hoods with malfunctioning or inoperative ventilation fans. We also observed hoods vented through duct work that was perforated. Finally, we also found that

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all the hoods serving the science area were constructed so that the hood exhaust was located adjacent to the hood intake. As a result materials evacuated by the hood could be re-entrained by the intake and brought back into the classroom.

IV. Problems or concerns noted:

- Chemical odors have been reported in the science department and elsewhere in the school.
- Neither the staff nor the students had been provided training in terms of how to safely use the chemical fume hoods or with regard to what uses are acceptable.
- All the hoods were found to be in a state of serious disrepair.
- The lack of mechanical ventilation in most science classrooms and other portions of the school system limits what activities can be safely conducted in these areas.
- The school department hired several contractors to inspect and repair the hoods - it took several tries to find a qualified professional able to adequately assess and repair the units.
- We have noted a reluctance by the staff to use centrally located hoods when conducting procedures that may adversely impact the indoor air quality.

V. Actions taken:

During my survey, I noted that the staff rarely used the chemical fume hoods in the science area. Upon closer examination, it became obvious that many of the units were in a state of disrepair. Our efforts to investigate and repair the fume hoods provides evidence of the need to hire a trained and competent professional to evaluate and maintain these units. During this review, we initially found that the exhaust fan had been removed from the majority of the units, presumably for energy savings. The remaining units were found to be equipped with improperly sized and balanced intake and exhaust fans. In addition, when tested with smoke, approximately half the units or associated ductwork were found to leak contaminants into the building. A final and fatal flaw was also detected for all chemical fume hoods. All hoods were found to be constructed with the exhaust located adjacent to the intake for each unit, consequently even if functional, the hoods could not remove contaminants from the classrooms and laboratories without re-introducing the materials to the building.

We have worked with an architect and a certified industrial hygienist to correct and resolve these deficiencies. We have also provided the staff with additional training regarding the safe and proper use of the hoods. In addition, each hood has been labeled to indicate the safe work area within the hood as well as the proper sash height for safe operation.

An inexpensive tip for screening the function of a chemical fume hood is to test the unit using a 60 to 90 second colored smoke bomb. If the unit is functioning properly it should easily evacuate the smoke to the outdoors. Common problems you may observe would be the failure of the smoke to exit the unit, smoke leaking from the hood or ductwork, and smoke re-entering the intake or the building ventilation system. One word of caution would be to coordinate all smoke tests with your fire department to ensure that all area smoke detectors have been disabled prior to testing. This graphic and inexpensive demonstration can be a useful indicator of whether a serious problem may exist. This test does not replace the need to have the units tested and re-calibrated on annual basis by a competent professional. Also, all units found to display improper air flow should be removed from service until inspected and repaired.

Lessons learned:

1. ***You must test and re-calibrate your hoods annually in order to ensure that they function properly.*** Be sure to use a qualified personnel when completing this task.

2. ***Provide your staff and students with training and guidance in terms of the safe and effective operation of chemical fume hoods.*** Many individuals fail to realize that the plexi-glass sash provided on most units is designed to function as a safety shield in the event of a minor explosion or that proper air flow can only be achieved when the sash is set at a specific height. You need to inform the user of each feature associated with your hoods.

Tips and suggestions:

1. ***Use a smoke bomb to test mechanical ventilation:*** This simple and inexpensive test can provide you with a quick and easy qualitative assessment of the function of a chemical fume hood or kiln exhaust. The use of brightly colored smoke will enable you to easily determine if exhaust may be escaping from the test unit, the ductwork associated with the unit, or if the exhaust is re-entering other portions of your ventilation system. This is only a quick and dirty analysis designed to check for major problems. This approach does not replace the need to have a trained professional inspect, maintain and calibrate these units.

2. ***Seek assistance from local resources:*** We are all in this together. Tap into the assistance that is available from federal, state and local environmental, and health and safety agencies. Do not overlook local residents, corporations, and medical facilities. These groups have a vested interest as parents and tax payers, and are frequently willing to provide technical expertise and assistance.

3. ***Rotate classroom activities or utilize centrally located hoods when conducting potentially hazardous procedures:*** Due to the cost of constructing and maintaining chemical fume hoods and the amount of use the units frequently receive, it is rarely justifiable that each science classroom or art studio should be equipped with a hood. A more cost effective solution would be to rotate classroom activities and to utilize

centrally located hoods when potentially hazardous procedures are to be conducted.

4. ***Adopt a microscale curriculum:*** The microscale concept is to alter your experimental procedures so that you use approximately 1/10th of the amounts originally planned for by the author. Conversion to microscale may require the purchase of new glassware, however the benefits include the development of better techniques by the staff and students, decreased chemical usage, lowered exposure to hazardous materials, and a reduction in hazardous waste generated. For more information describing microscale contact: Dr. Mono M. Singh, Director, The National Microscale Chemistry Center, 315 Turnpike Street, Merrimack College, North Andover, Massachusetts 01845, Telephone: (978)837-5137, Fax: (978)837-5017, or via e-mail at 'msingh@merrimack.edu'.

5. ***Adopt a less toxic curriculum:*** As previously suggested, you must review the curriculum to determine if safer, less toxic alternatives can be implemented. I have found that frequently many options exist for providing the same educational experience, however some motivation must be provided to prompt the search for a safer alternative. I recommend that you consult your state pollution prevention agencies for assistance. In Massachusetts, we are fortunate to have the Office of Technical Assistance and Surface Cleaning Laboratory. These agencies provide free, non-regulatory pollution prevention assistance to the public. In Burlington, we have also adopted a number of procedures presented in "40 Low-waste, Low Risk Chemistry Labs", by David Dugan, published by J. Weston Walch of Portland, Maine (207-772-2846). We have found this text to provide a more detailed discussion of EHS issues associated with the procedure combined with the use of less toxic alternatives than normally found in most chemistry text books.

Resources:

1. ***Internet resources:*** The following is a compilation of useful internet addresses that may assist you when researching EHS or regulatory issues.

Address	Site Description
http://www.osha.gov	OSHA regulations & guidance
http://www.acs.org	American Chemical Society
http://www.aiha.org	American Industrial Hygiene Association
http://turva.me.tut.fi/~tuusital/oshlinks.html	Index of health & safety resources on net
http://www.artswire.org	Center for Safety in the Arts
http://www.ABIH.org	American Board of Industrial Hygiene
http://www.mrg.ab.ca/christie/safe1.htm	Searchable safety database
http://www.baqa.org	Building air quality alliance

2. ***Potential sources for written guidance describing school EHS issues:***

The Maryland Department of Education has published a number of helpful technical bulletins describing potential EHS issues in schools as well as potential corrective action.

Maryland Department of Education
Office of Administration and Finance
Office of School Facilities
200 West Baltimore Street
Baltimore, Maryland 21201
(301)333-2508

The Center for Safety in the Arts monitors and evaluates a broad range of health and safety concerns involving the arts and theater. This group has also published a large volume of health and safety guidance.

Center for Safety in the Arts
5 Beekman Street, Suite 820
New York, New York 10038
(212)227-6220

The National Microscale Center at Merrimack College has prepared guidance describing the benefits as well as how to initiate a microscale curriculum. The center also conducts training for those wishing to develop a microscale program.

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Chemical Management
Asbestos Management
Indoor Air Quality
Pesticide Usage
Mercury Management
Radioactive Materials
Fire Prevention
Pollution Prevention
Hazardous Waste
Formaldehyde
Radon
Chemical Fume Hoods
Eye Washes
Safety Equipment
Hazards By Department
Emergency Response
Ceramic Kilns
Underground Tanks
Classroom Lasers
Sanitary Drains

EHS PRIMER

A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Emergency Eyewash Units

I. The Issue:

Even after a thorough hazard analysis, a review of safety procedures, and the proper use of personal protective equipment, accidents can still happen. In the case of accidental chemical exposures to the eyes a quick and effective response is essential to prevent lasting damage or a loss of sight. In addition, federal health and safety regulations exist which specifically mandate that emergency eyewash units must be installed and maintained where corrosive chemicals will be used. Regardless of the legal requirements, most would agree that it is a prudent practice to install and maintain an emergency eye wash unit wherever a chemical or physical hazard may pose a serious risk of injury to someone's eye.

II. The approach taken:

As public employees, the school department staff are not under the purview and jurisdiction of the federal Occupation Safety and Health Administration. In addition, the Commonwealth of Massachusetts has not formally adopted emergency eyewash standards for public employees. Based on the lack of legal requirements, we decided to use the federal requirements outlined in 29 CFR 1910.151(c) as well as the guidance specified in the American National Standards Institute (ANSI) Emergency Eyewash Standard that OSHA has adopted as a consensus standard as a minimum local standard. In addition, we felt that it may be appropriate to seek the installation of eyewash units wherever a chemical or physical hazard may injury an eye rather than just were corrosive liquids were used as specified in the federal standard.

Using this criteria, we identified the following areas where the installation and maintenance of an eyewash may be most appropriate: the high school and middle school science laboratories, the high school woodworking shop, the high school ceramics area, the Burlington science center, and the school department chemical storage warehouse. An initial assessment of these areas determined that emergency eyewashes were only available in four of the high school science laboratories.

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III. Observations made:

An initial survey of eighteen rooms and laboratories where activities occurred that could result in eye injuries determined that only four of the rooms were equipped with emergency eyewash units. These units were located in two chemistry classrooms and two adjoining laboratories. As a result only a limited emergency response was possible in the remainder of the school district.

Another observation noted during the initial survey was that the eyewash units were not always free of debris and appeared to be subject to abuse and vandalism. In addition, there existed confusion amongst the school department staff with regard to who was responsible for testing and maintaining the eyewash units. Furthermore, we could not locate records which indicated that the flow rates had been monitored on a semi-annual basis or if the units had been tested on a weekly basis as recommended by OSHA. Several tests of the units conducted during our initial review resulted in the observation of rusty water discharging the units. This suggested that the units may not have been discharged on a weekly basis as suggested by OSHA.

Another observation noted was that much of the staff did not believe that significant eye hazards existed in their work area, and consequently many did not place importance on installing and maintaining an eyewash unit in their work area. Also, those staff members that had been provided with eyewash units automatically assumed the units would work if needed, but these staff members did not actively inspect, test or monitor the units for access or proper operation.

IV. Problems or concerns noted:

- Emergency eyewash units were not available in most of areas where potential eye injuries could occur.
- No records are available to indicate when and how the existing eyewash units are inspected and maintained.
- Upon testing, the existing units have been observed to discharge rusty water which could aggravate an injury or cause an individual not to use the unit.
- Additional eyewash units have been purchased, unfortunately not all the new units comply with the ANSI design and operation standards.
- Confusion still exists with regard to who should inspect and maintain the eyewash units, consequently many routine inspections of these units are not completed.
- Several areas where optical hazards exist have not yet been equipped with eyewash units.

V. Actions taken:

A. We developed a local protocol to determine areas where activities occurred that could pose the risk of an eye injury.

We used the requirements of the federal Occupational Safety and Health Administration standard 29 CFR 1910.151 and the ANSI Emergency Eyewash protocol that OSHA has adopted as a consensus standard for the basis for our approach.

B. Using the local standard, we surveyed the school district to identify activities that posed a potential risk.

Using this information, we identified the following locations where chemical and physical hazards existed that could result in eye injuries: the high school and middle school science laboratories, the high school woodworking shop, the high school ceramics area, the Burlington science center, and the school department chemical storage warehouse.

C. Additional eyewash units were purchased for some of the hazard areas.

Additional eyewash units have been installed in high school and middle school science laboratories.

Lessons learned:

1. ***Buy ANSI approved eyewash units and not faucet mounted units.***

Most of the eyewash units purchased in order to enhance eye protection within the school district were faucet mounted units. Two types of units have been purchased. One unit has a single hand held nozzle that is connected to the faucet by a screw on hose. The second unit has a double nozzle dispenser that can be mounted on the faucet. This unit is also connected to the faucet by a screw on hose. The problems with these units include that the units are not always connected to the faucet and ready for immediate operation. In addition, the single dispenser unit must be held when operated and may not provide adequate coverage for both eyes, consequently it may be difficult to rinse the eyes without assistance.

The recommended approach would be to utilize an eyewash which complies with the following minimum design parameters established by ANSI. The unit should be capable of providing 0.4 gallons of tepid water per minute for 15 minutes via two dispensing units. The unit should also be self discharging so that the operator's hands are free to assist with the flushing process. This is important because the injured party may be required to hold their eye lids open or remove contact lenses.

2. ***Develop a plan and designate responsibility for inspecting, testing and maintaining the units.***

The establishment of an inspection and maintenance plan is critical for ensuring that access to the units is maintained at all times and that the units are clean, sanitary, and fully functional at all times. Routine inspection and testing will promote this as well as prevent the build up of sediment or rust within the unit.

Tips and Suggestions:

1. ***Have someone who has been injured discuss the accident with staff and/or students.***

A first hand account can have a tremendous impact on the unconvinced. Your local hospital may be able to assist you in locating a speaker.

2. ***Do not purchase faucet mounted units.***

These units will frequently be disabled so that the faucets can be used for other purposes. As a result, valuable time can be lost while someone tries to re-assemble the device during a crisis.

Resources:

During this investigation, I utilized the resources available via the U.S. Department of Labor - Occupational Safety and Health Administration, and the American National Standards Institute. These groups can be contacted via the internet at:

OSHA	http://www.osha.gov
ANSI	http://www.ansi.org

prepared by
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Chemical Management
Asbestos Management
Indoor Air Quality
Pesticide Usage
Mercury Management
Radioactive Materials
Fire Prevention
Pollution Prevention
Hazardous Waste
Formaldehyde
Radon
Chemical Fume Hoods
Eye Washes
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Emergency Response
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A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Safety Equipment

Introduction:

The following is a general summary of the types of safety equipment that should be made available within a given school system as well as general locations where the protective equipment or devices should be maintained and used. The observations noted during the completion of our investigation serve as the basis for these recommendations. The reader should note that this is only a partial list and that your school system should be reviewed for unique hazards and site specific hazards at each facility. For example, the Burlington school system does not sponsor a large industrial arts or shop curriculum locally and as a result many of these hazards have not been fully assessed during our review.

Safety Equipment/Procedures:

1. *Training.* Train your staff on how to:

   a) identify potential hazards,
   b) evaluate potential hazards, and
   c) how to prevent or respond to hazards.

The following types of training should be considered:

   a) Right to Know along with some basic chemical hygiene as well as how to read and understand a material safety data sheet, b) instruction in how to use a fire extinguisher,
   c) instruction in how to use a chemical fume hood,
   d) general guidance in when and how to use personal protective equipment (e.g. safety glasses or gloves), and
   e) instruction in how to monitor activities for potential impacts on indoor air quality. *(Note: The EPA Tools for Schools Indoor Air Quality Assessment kit can assist your efforts to review air quality concerns.)*

2. *Material Safety Data Sheets.* Maintain a copy of the material safety data sheet for every item in your chemical inventory. This information will assist you in determining how to store and handle your materials by outlining the health and safety hazards posed by the substance. In most cases the manufacturer will provide

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recommendations with regard to protective equipment, ventilation and storage practices. This information should be your first guide when considering the use of a new material.

3. *Safety glasses/goggles.* Safety glasses or goggles should be used during all activities where chemicals or particles may accidentally enter the eye. Common settings include middle and high school science labs, art studios, maintenance and shop areas. In Massachusetts, state law specifies that safety glasses shall be worn whenever hazardous chemicals are used in the classroom. Be sure to review and consider the types of hazards present when selecting appropriate eye protection. Make sure you select equipment that is designed to provide protection for the risks under consideration.

4. *Gloves.* Many chemicals can either damage the skin via contact or may cause harm if allowed to be absorbed through the skin. As a result, it is important to use protective gloves to form a barrier to prevent these problems. Also, remember that different hazards require the use of different gloves. It is rare that one type of glove would be capable of providing adequate protection for all the hazards that may be encountered. This is especially true with regard to the variety of chemistry that may be found in science laboratories. Common settings include middle and high school science labs, art studios, maintenance and shop areas.

5. *Lab coats and aprons.* Labe coats and aprons are designed to provide protection in the event of a spill. In addition, the use of these articles may prevent student or staff clothing from becoming contaminated and thereby limit the migration of chemical contamination should a spill occur. Common settings include middle and high school science labs, art studios, maintenance and shop areas.

6. *Eye wash units.* Eye wash units should be provided in all areas where chemical or physical hazards exist which may cause eye irritation or injury. Common settings include middle and high school science labs, art studios, maintenance and shop areas.

7. *Deluge showers/fire blankets.* Deluge showers and fire blankets should be maintained in all areas where chemical or fire hazards exist which may result in partial body exposure. Common settings include middle and high school science labs, art studios, maintenance and shop areas.

8. *Fire extinguishers.* Fire extinguishers should be maintained in accordance to state and local fire and building codes. Furthermore, each area should be reviewed individually to determine if additional fire protection is required. Also, be sure to verify that the correct size and type of extinguisher is provided in accordance to the materials commonly used or maintained in that space.

9. *Ventilation.* Additional mechanical ventilation such as chemical fume hoods should be provided in all areas where chemical fumes, vapors or odors are commonly generated. Sufficient ventilation should be provided to prevent the build up of hazardous air contaminants and to minimize nuisance odors. This may be an issue in middle and high school art, science and shop classrooms as well as facilities maintenance shops.

10. *Respirators.* Respirators are not generally recommended for student use, but their use by maintenance staff may be required when conducting certain activities such as pesticide application or asbestos management. All readers are encouraged to consult the guidance prepared by the federal Occupational Safety and Health Administration regarding the use and maintenance of respirators.

11. *Hearing protection.* Certain shop and maintenance activities may necessitate the need to wear hearing protection. Each school system is encouraged to investigate all activities which generate loud or persistent noises for evaluation by a trained certified industrial hygienist.

12. *Spill kits.* Spills will occur. Be prepared to address and respond to the problem. This approach will enhance your ability to remediate a spill and minimize its long-term impact. Common settings include middle and high school science labs, art studios, maintenance and shop areas.

13. *Chemical storage cabinets.* The bulk storage of hazardous materials may necessitate the use of a re-enforced chemical storage cabinet. This method of storage is routinely used to manage flammables, corrosives and oxidizers. Review local fire prevention guidance for storage recommendations.

Tips:

1. ***Use your safety equipment.*** If you do not use your equipment then it cannot protect you. Also, you need to be prepared to punish or penalize those who will not use the safety equipment. Their actions may endanger more than one person.

2. ***Develop a less toxic curriculum.*** This approach may enable you to avoid or minimize the number of safety hazards requiring special precautions at your school in the first place.

Resources:

Potential sources of assistance include state public health and occupational hygiene agencies as well as the federal Occupational Safety and Health Administration. The local fire service and code enforcement offices may also assist your efforts to promote fire prevention and proper chemical storage.

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A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Hazards by Department

I. The Issue:

This section provides a general listing of the types of hazards found within each section of the local school system. These concerns have been broken down and listed by grade level and where appropriate by individual departments within various grade levels. Only a limited discussion of each hazard is provided in this section. Please refer to the appropriate section within the case study for more information on a particular concern. I have attempted to list all the hazards or concerns that have been noted during our review. We have made efforts to resolve many of the items noted.

II. Observations made:

Hazards or concerns common to all local schools:

The following issues and concerns have been noted at all or most of the local schools.

1. We have found damaged asbestos in many of the local schools. The degree of damage, type of asbestos containing material involved, and the location of the material will determine the significance of the hazard presented by the material.

2. Asbestos containing material is present in all local schools. The presence of this material requires that we remain vigilant to ensure that future renovations and utility installations do not damage this material and result in the uncontrolled release of asbestos.

3. The water quality provided by the cafeteria sinks and drinking fountains should be tested on a regular basis. We have found that the acidic nature of the local water has caused these fixtures to leach lead and copper if the water is allowed to remain stagnant. You should consider your water source and local contaminant concerns when developing a sampling strategy.

4. We found hazardous chemicals present at all local schools. These materials were used by both the maintenance staff as well as part of the curriculum.

5. We found flammable liquids present in all local schools. The most common materials were methanol based duplicating fluid, oil based paints

and thinners, and petroleum based solvents. The presence of these materials represents a potential fire hazard.

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6. A review of waste streams indicated that each school generated some form of hazardous waste. As a result, each facility needed a method for identifying and properly managing the hazardous waste generated by the school.

7. In addition, each school generates universal waste (e.g. fluorescent lamps, electric ballast's, mercury switches, computer components, and batteries) which must be properly recycled or disposed of as hazardous waste to ensure environmental protection and regulatory compliance.

8. All of our schools were originally heated using an oil burning heating system, consequently each building was originally constructed with an underground oil storage tank. These fuel storage systems will continue to pose a risk of environmental release until the tanks are taken out of service and removed for disposal.

9. Several local schools have experienced indoor air quality problems as the result of water damage caused by leaking roofs or floods. The presence of moisture has promoted the growth of mold and mildew at several locations. These growths can generate serious allergic responses in the effected population.

10. Air quality concerns related to the use of various volatile chemicals have also been noted at several schools. The majority of the complaints have been associated with the use of adhesives, aerosols, paints, solvents, and pesticides.

11. We have also noted indoor air quality concerns associated with the design and maintenance of the heating and ventilation system. These problems have been related to improper rate of fresh air exchange, and poor temperature control. We have also noted a large number of improper modifications that were implemented as a means to promote energy efficiency by reducing the rate of fresh air exchange.

12. A number of internal pollutant sources have been identified in the local schools which may degrade air quality. Some of the potential problems include: unventilated kilns, spray booths, animals, plants, chemical storage and usage, and sanitary drains.

13. We have noted resistance to respond to the detection of chemical clouds/odors in the local schools. In addition, the administration has displayed a willingness to discount the report of possible health effects associated to chemical releases in the local schools.

14. A review of the fire extinguishers maintained at the local schools has detected the following types of problems: units missing or obstructed, a failure to annually inspect and service all fire extinguishers, the failure to provide the proper type of extinguisher for the types of fires that may

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occur in that area.

15. Poor chemical management has been a common problem noted in local schools. These problems have been related to: unsecured chemical storage in the classroom, open chemical containers in boiler rooms or maintenance areas, and the joint storage incompatible substances in classrooms and maintenance areas.

16. A review of staff training indicated that improvements could be made in the following areas: asbestos management, fire extinguisher usage, chemical management, right to know, spill response, and indoor air quality assessment. Many of the staff members expected to participate in these areas had received little or no training in these areas.

17. In most cases, even the most basic personnel protective equipment such as rubber gloves and safety goggles were not available for staff or student use.

18. In addition, many of the schools did not possess spill response materials or a spill response plan. The maintenance of a basic response level capable of mitigating a 5 to 10 gallon release could significantly enhance our ability to prevent a small nuisance leak or spill from becoming a very costly problem. You also need to consider the types of materials that may be spilled: petroleum products, corrosives, mercury.

19. A significant problem noted was that no one employed by the school system had been assigned the task or made accountable to investigate or resolve environmental, health and safety concerns or complaints. As a result, such complaints were either ignored, disputed or referred to a consultant for resolution without consideration for the original cause. This resulted in the long term persistence of many hazards.

20. We also noted that many schools could not identify all chemicals present on site. In addition, many could not locate a material safety data sheet for each item maintained in their chemical inventory.

The following is a listing of special or unique hazards located within specific schools or departments in addition to the items listed previously.

Elementary Schools:

1. We noted the presence of a variety of hazardous chemicals in pre-packaged laboratory instructional aids which posed a hidden hazard. The contents of these kits were often overlooked or forgotten by the staff. A review of these materials indicated that many of these materials and the hazards associated with the materials were poorly identified (sample labeling: solution A, toxic, do not consume). Frequently, these kits did not contain material safety data sheets to identify health and safety concerns or treatment measures should someone ingest or absorb the material. In addition, during our research we found containers of concentrated corrosives and confirmed human carcinogens in kits purchased for use by

elementary school children. We also noted that the older the kit, the greater the likelihood that the chemical contents were toxic and poorly identified.

2. All the ceramics kilns operated at the local elementary schools were found to vent directly into the schools. This practice resulted in the release of carbon monoxide, volatile organic compounds and ozone into the schools. As a result, the indoor air quality may have been degraded by the operation of these devices.

Middle School:

1. We noted the presence of a variety of hazardous chemicals in pre-packaged laboratory instructional aids which posed a hidden hazard. The contents of these kits were often overlooked or forgotten by the staff. A review of these materials indicated that many of these materials and the hazards associated with the materials were poorly identified (sample labeling: solution A, toxic, do not consume). Frequently, these kits did not contain material safety data sheets to identify health and safety concerns or treatment measures should someone ingest or absorb the material. In addition, during our research we found containers of concentrated corrosives and confirmed human carcinogens in kits purchased for use by the students. We also noted that the older the kit, the greater the likelihood that the chemical contents were toxic and poorly identified.

2. While reviewing the chemical inventory, we noted that initially the bulk of the chemical inventory maintained by the science department was stored unsecured in the classrooms. In addition, these materials were not stored in approved chemical storage cabinets. As a result, the materials may have been subject to tampering and theft. Furthermore, this method of storage did not provide adequate fire protection for the chemical inventory and could have posed a health and safety hazard for the local emergency responders.

3. A review of the contents of the chemical inventory indicated that inappropriate types or quantities of hazardous materials were maintained at the middle school. These materials either posed inappropriate health hazardous (e.g. carcinogens) or the volumes present represented excessive quantities (pounds of water reactive sodium) based on the current rate of usage.

4. The ceramics kiln operated at the middle school was found to vent directly into the school. This practice resulted in the release of carbon monoxide, volatile organic compounds and ozone into the school. As a result, the indoor air quality may have been degraded by the operation of this device.

5. A review of the classrooms used for the instruction of science determined that many of the rooms had not been provided with safety and personnel protective equipment. Few of the classrooms had been equipped with emergency eye washes or safety glasses.

6. The design and construction of the science classroom facilities limit what activities may be conducted. Specifically, none of the rooms had been constructed with a chemical fume hood. The lack of mechanical ventilation severely limited the type of activities and procedures that could be safely conducted in the school without adversely impacting indoor air quality.

High School:

Science Department

1. A survey of this area found that chemicals were routinely stored in the classrooms. Each room averaged more than 100 chemical containers. These materials were stored unsecured on shelves and in cabinets and drawers. Frequently, these containers were not stored or arranged in an organized manner. As a result, the materials were subject to theft and tampering. In addition, this practice posed a significant health and safety hazard to the local emergency responders due to the lack of fire protection and the joint storage of incompatible materials.

2. A review of the inventory detected a large number and volume of highly toxic or reactive materials (explosives, peroxide formers (shock sensitive explosives) , water reactives, and radioactives). During our research, we found that most of these items could be eliminated or replaced by less hazardous alternatives as a means to promote occupational safety.

3. A survey of the science area indicated the majority of the classrooms and laboratories were not initially equipped with chemical fume hoods, emergency eye wash units, deluge showers, safety glasses or protective gloves. The lack of these protective devices created limits in terms of what activities could safely be conducted in these rooms.

4. A review of the curriculum determined that a number of the routine experiments and procedures utilized by the science staff could impact the health and safety of the faculty and students. Initially, common laboratory procedures routinely involved the use of a variety of carcinogenic, and flammable volatile organic solvents. These activities were often conducted without the use of personnel protective equipment and in settings that lacked mechanical ventilation.

5. Another concern noted was that the staff had limited training and understanding of the health and safety concerns associated with the experimental procedures commonly utilized by the department. As a result, we had to provide the staff with additional training so that they could assist with identifying and resolving health and safety concerns within the department.

6. A number of the procedures and experiments used by the department were found to pose a potential risk to the indoor air quality. The following

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activities were identified as likely to adversely impact indoor air quality: a) the storage and use of biological specimen, b) the heating of experiments and reagents, and c) the storage and use of volatile materials and aerosols.

7. The handling, repair and disposal laboratory equipment and devices may create a variety of environmental, and health and safety issues. We have found these items to contain a collection of hazardous components requiring special care or management as part of routine maintenance or prior to disposal. Examples of potentially hazardous components include: ballast's or capacitors containing polychlorinated biphenyl's, mercury switches, batteries, and hydraulic fluid.

8. The Burlington Science Center maintains a small zoo at the high school. As a result, the housing of animals inside the building may allow allergens to be released into the school. The generation and release of allergens by the animals may degrade the local air quality and trigger an allergenic response in the effected population.

Art Department

1. The ceramics kilns operated at the high school were found to vent directly into the school. This practice resulted in the release of carbon monoxide, volatile organic compounds, metal fumes, and ozone into the school. As a result, the indoor air quality may have been degraded by the operation of these devices.

2. Historically, the high school ceramics program has mixed and prepared its own clay and glazes using a variety of powdered clays, firing additives and heavy metal powders. These activities have resulted in the generation of hazardous dusts containing free silica and toxic heavy metals that have impacted local indoor air quality.

3. The use of various aerosols by the art department without adequate ventilation has on occasion been found to be the source of irritating nuisance odors in the school. As a result, the indoor air quality may have been adversely impacted by these activities.

4. Another indoor air quality and comfort concern has been noted in association with the computer graphics lab operated by the art department. The operation and maintenance of a large amount of computer equipment in a small poorly ventilated room may have promoted the generation and accumulation of ozone and volatile organic compounds in this area. In addition, the heat generated by this equipment caused the temperature to frequently rise to uncomfortable levels in this area while also promoting a decline in the relative humidity. These conditions could irritate mucus membranes and make the occupants more sensitive to indoor air contaminants released by the equipment.

5. In addition, we also noted a lack of safety equipment for use by ceramics and sculpting program. These areas had not been equipped with

safety glasses, emergency eye wash units or protective gloves for staff or student use.

Facilities Maintenance

1. The primary concern has been the warehousing of maintenance materials without regard to chemical compatibility. This practice has proven to be and continues to be serious hazardous materials management concern should a fire occur.

2. The use of flammable and volatile products by the maintenance staff has posed a variety of indoor air quality and fire safety concerns at all local schools.

3. Improper asbestos management and abatement has also been found to be a significant concern. Asbestos abatement conducted by the maintenance staff has resulted in the contamination of at least one local school and may have placed the staff and students at risk. Proper asbestos management will remain a long-term issue due to the prevalence of asbestos containing material in the local schools. School renovation combined with additional utility installation and improvement will cause asbestos management to become increasingly problematic.

Resources:

In this section, I have attempted to provide a brief listing of the major concerns and issues we have noted during our evaluation of the local school system. A more detailed accounting of the investigation and resolution of these issues may be found within the individual sections of the case study.

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Spill and Emergency Response Plans

I. The Issue:

Whenever you use or store chemicals there exists the possibility that an accidental spill or release may occur. Best management practices recommend that you plan for this possibility by preparing a spill response plan outlining how you can respond to a release and by maintaining the spill response materials described in your plan at your site. By being prepared it may be possible to prevent a small spill from becoming a major hazmat incident.

II. The Approach Taken:

Unfortunately, the local school system has a well documented history of chemical spills and accidents which clearly indicate the need to establish and maintain a spill response plan. As a result, there was less of a need to assess the likelihood of a spill occurring at a local school. Instead, we focused our efforts on determining the types of materials that could be spilled and which locations were most likely to experience a release. This involved a review of the chemical inventories as well as materials management practices.

III. Observations Made:

We found that the greatest risk of a chemical spill existed in the following areas: the high school science area, the school department central maintenance and storage areas, and the boiler rooms at each of the schools. We also attempted to identify the different types of materials that could be released which could create health and safety concerns if not properly mitigated. We identified the following materials of concern: mercury, corrosives, flammables, and petroleum based materials. The physical and chemical differences between these materials meant that in most cases different spill response materials would be needed to remediate different releases.

We also noted that initially none of the staff had been trained in spill response and that the school department possessed few spill response materials. We also observed that a written spill response plan had not been prepared for use by the school department staff.

IV. Problems or Concerns Noted:

- The risk of a chemical release was present at all local schools.

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- Few spill response materials were readily available at the local schools. *No spill response materials were available for certain classes of materials (e.g. mercury).*
- Initially, none of the staff had been trained in spill response.

V. Actions taken:

Several staff members within the high school arts and science departments along with members of the maintenance staff have been provided with spill response training. We used the guidance and direction outlined in the OSHA HAZWOPER Standard 29 CFR 1910.120 for the 8-hour First Responder Training classification as the basis for our training. Our intent is to have these individuals assess the situation and to address minor releases, if possible. All large or more hazardous releases are to be referred to the local hazardous materials response team operated by the Burlington Fire Department.

In addition, we have also made efforts to obtain the appropriate spill response materials needed to respond to the various types of materials present at the public schools. Spill materials are now stored in the high school science department and in the central maintenance area at the high school. The school department has also been encouraged to store spill response materials in the boiler room of each school as a pre-caution.

Tips and suggestions:

Seek assistance from local resources. We are all in this together. Tap into the assistance that is available from federal, state and local environmental, and health and safety agencies. Do not overlook local residents, corporations, and medical facilities. These groups have a vested interest as parents and tax payers, and are frequently willing to provide technical expertise and assistance.

Resources:

State and federal environmental, occupational hygiene, and public health agencies may be able to provide you with guidance and direction when assessing your spill response needs. In addition, local corporations or institutions may be willing to provide training assistance or guidance when you attempt to address this issue.

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Ceramic Kilns

I. The Issue:

The operation of a ceramic kiln may pose a risk to indoor air quality if the unit is not properly maintained and mechanically ventilated to the outdoors. In addition, the introduction of certain synthetic materials during the firing process may create unusual and hazardous emissions. As a result, it is prudent to review the use of all kilns as well as the ventilation system provided to each unit. Failure to maintain and safely operate ceramic kilns located indoors may degrade indoor air quality and result in the accumulation of harmful concentrations of carbon monoxide, ozone, volatile organic compounds, and metallic vapors.

II. The approach taken:

As part of a comprehensive indoor air quality assessment of the local school system, we endeavored to identify potential sources of indoor air pollutants. During this process, we identified five ceramic kilns operated inside local schools. Each kiln was then inspected for concerns related to its use and operation.

III. Observations made:

The most significant observation noted was that initially all the kilns vented directly into the schools where they were located. Three of the units had not been provided with any type of mechanical ventilation and were allowed to freely vent into the building. Two of the units had been provided with mechanical ventilation, unfortunately, several design flaws existed in the existing mechanical ventilation system which rendered the system ineffective. As a result, the operation of these units may have adversely impacted the indoor air quality at each school.

Another concern noted was the practice of introducing synthetic materials such as plastic or mothballs during the firing process as a means to create a new or unique lustre on the ceramic piece. Mothballs and stryofoam are examples of some of the synthetic materials that may be introduced during the firing process to develop a unique lustre. This is reported to be a common practice among ceramic artisans as a means to develop and express an artistic signature. The problem is that these synthetic materials tend to produce hazardous and/or carcinogenic emissions when fired.

A hazard associated with ceramics but unrelated to the operation of kilns is the generation of free silica. A review of the clays used by our schools

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indicated that these materials contain between 20% to 90% free silica. Free silica is a concern because it is physically similar to asbestos. In addition, free silica is a severe respiratory hazard. As a result, efforts should be made to minimize the amount of dust generated while preparing ceramic pieces. Furthermore, all dust generated by these activities should be assumed to contain free silica and should only be cleaned up via damp mopping. Sweeping or vacuuming could re-suspend the free silica and increase the respiratory hazard posed by this material.

IV. Problems or concerns noted:

- Initially all five kilns vented combustion by-products into the school buildings.
- The introduction of various synthetic materials into the kilns during firing may have resulted in the generation of highly toxic emissions.
- Most activities related to the preparation of ceramic pieces involve the potential for exposure to free silica, a significant respiratory hazard.

V. Actions taken:

The high school art department maintains two kilns which area located in an interior room lacking a window. Proper venting of the kilns is critical in order to prevent the degradation of indoor air quality. The operation of a ceramic kiln commonly results in the generation of carbon monoxide, volatile organic compounds, and metallic vapors. Initially, the kiln room was vented to the outdoors via a manually operated ceiling mounted exhaust fan which was ducted thirty feet to the outdoors. The discharge for this ductwork was 10 feet below the roof line within a partially enclosed area and adjacent to the discharge was an inoperative louver fan for the ceramics studio. The following problems existed with this design. First, the kiln exhaust was not ducted to the exhaust fan but allowed to be passively drawn to the fan. This approach allowed the kiln emissions to escape the kiln room via two door ways or via the building heating and ventilation system which also serviced the kiln room. In addition, the operation of the exhaust fan was manually operated by the staff and students and due to its noisy operation most individuals preferred not to use the fan. Furthermore, it was questionable that the exhaust fan was capable of transporting captured emissions the required thirty feet and discharging the material via the louvered opening. Finally, it is likely that a portion of those materials that were discharged by the exhaust system probably re-entered the building via the louvered fan located adjacent to the kiln exhaust discharge.

We addressed these problems by installing bottom mounted exhaust fans on both kilns. The kiln exhausts were also ducted directly to the existing exhaust system which was equipped with two quieter booster fans. The exhaust system was also modified to discharge above the roof line. The exhaust system has also been hard wired to operate whenever the kilns are in operation.

While reviewing the art supplies in the middle and elementary school, I noted that all the kilns located at these schools vented directly into the schools. As a result, carbon monoxide, volatile organic materials and other emissions were being released into the schools whenever the units were fired. This resulted in a degradation of the indoor air quality of these schools. This problem was addressed by installing the appropriate ductwork and exhaust fans to vent the units outside.

The potential hazards associated with introducing synthetic materials into the kiln during the firing practice have also been discussed with the staff. We have requested that the staff and students refrain from this activity. We are concerned that the ventilation systems may not be able to remove all of the hazardous by-products generated by this activity.

Tips and suggestions:

1. ***Use a smoke bomb to test mechanical ventilation:*** This simple and inexpensive test can provide you with a quick and easy qualitative assessment of the function of a chemical fume hood or kiln exhaust. The use of brightly colored smoke will enable you to easily determine if exhaust may be escaping from the test unit, the ductwork associated with the unit, or if the exhaust is re-entering other portions of your ventilation system. This is only a quick and dirty analysis designed to check for major problems. This approach does not replace the need to have a trained professional inspect, maintain and calibrate these units.

2. ***Seek assistance from local resources:*** We are all in this together. Tap into the assistance that is available from federal, state and local environmental, and health and safety agencies. Do not overlook local residents, corporations, and medical facilities. These groups have a vested interest as parents and tax payers, and are frequently willing to provide technical expertise and assistance.

Resources:

I utilized the services and expertise of the following groups and agencies while reviewing the health and safety concerns associated with ceramic kilns.

Massachusetts Office of Technical Assistance
Attn: Lisa Dufresne
100 Cambridge Street, Room 2109
Boston, Massachusetts 02202
Telephone: (617)727-3260
Fax: (617)-727-3827

This agency provides free, non-regulatory technical assistance to schools located in the Commonwealth of Massachusetts. This agency also maintains a large database of technical information describing the investigation and resolution of a broad variety of potential environmental, health and safety issues that are commonly found in schools.

Massachusetts Dept. of Labor & Workforce Development
Division of Occupational Safety
Attn: Nancy Comeau
1001 Watertown Street
West Newton, Massachusetts 02165
(617) 969-7177
fax: (617)727-4581

This agency provides free technical assistance to schools located in the Commonwealth of Massachusetts. This agency also maintains a large database of technical information describing the investigation and resolution of a broad variety of potential environmental, health and safety issues that are commonly found in schools.

Center for Safety in the Arts
5 Beekman Street, Suite 820
New York, New York 10038
(212)227-6220
internet: http://www.artswire.org

The Center for Safety in the Arts monitors and evaluates a broad range of health and safety concerns involving the arts and theater. This group has also published a large volume of health and safety guidance. They also offer a variety pollution prevention information.

Maryland Department of Education
Office of Administration and Finance
Office of School Facilities
200 West Baltimore Street
Baltimore, Maryland 21201

The Maryland Department of Education has published a number of helpful technical bulletins describing potential EHS issues in schools as well as potential corrective action.

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A Case Study of Environmental, Health and Safety Issues Involving the Burlington, Massachusetts Public School System

Underground Storage Tanks

I. The Issue:

Experience has shown that the filling and use of underground tanks for the storage of hazardous materials such as petroleum may result in the accidental release of the stored material. In addition, a number of studies have found that approximately 50% of all underground storage systems begin to degrade and fail within fifteen years after installation. Furthermore, tanks with a smaller volume and constructed of a lower gauge or thickness of steel tend to fail sooner than larger thicker tanks. The release of hazardous materials by these tanks may adversely impact the local environment by contaminating local soils, groundwater, and surface water. These impacts may create public health issues while also establishing state and federal regulatory responsibility and liability for the tank owner. As the owner and operator of underground storage tanks, it is imperative that we properly monitor and manage these systems to prevent the release of hazardous materials so that we can protect the health of the local citizenry and environment, and avoid unnecessary regulatory costs.

II. The Approach Taken:

In 1992, we began our effort by reviewing local records to determine if underground heating oil tanks were present at any of the local schools. We reviewed construction plans, tank installation and removal records, and consulted with school department personnel.

In 1995, the School Department investigated and removed its first underground storage tank during the renovation of a local elementary school.

In 1997, in response to the discovery of a number of leaking municipal underground storage tanks, the Town of Burlington initiated steps to investigate and remove all aging tanks owned or operated by the Town.

In June 1998, the Town of Burlington began efforts to investigate and remove six underground storage tanks from four local schools.

III. Observations Made:

As a result of this investigation, we found that at least one underground storage tank was present at each local school. The size of the tanks ranged from 500 to 20,000 gallons in capacity. The ages of the tanks ranged from 20 to 40 years of age. At several locations, we also noted that available

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records suggested that only one tank was present on site, but that the piping at the school suggested the presence of more than one tank. We also noted that many of the school department tanks had been abandoned in place after the department had converted the school heating systems to natural gas. In many cases the tanks were found to have been left in place unused for years. In addition, recent tank removal activities have determined that approximately 30,000 gallons of oil was left in place when these tanks were originally abandoned. One tank was found to contain approximately 18,000 gallons of aged fuel oil. These practices represent multiple violations of state and federal underground storage tank requirements. In general terms, all underground storage tanks in Massachusetts must be excavated and removed within two years of abandonment. As part of the removal process, a tank closure assessment must be completed to determine if environmental contamination has occurred. Also, the contents of each tank must be removed at the time when the tank is taken out of active service.

Between 1995 and 1997, we removed three underground storage tanks from school property. During this effort, we removed a 500 gallon tank (which was found to contain 500 gallons of diesel fuel at the time of removal), a 5000 gallon tank (which was found to contain 3000 gallons of heating oil at the time of removal), and an 8000 gallon tank. Contamination was discovered at two of these locations. The discovery of contamination triggered the Massachusetts environmental reporting requirements which then mandated that the town remediate these petroleum releases.

During the summer 1998, we will be attempting to remove at least six more tanks. Many of these tanks have been found to have residual oil in place. It is likely that we will detect additional contamination before this project is completed.

IV. The Problems or Concerns Noted:

- Local tank records are poor. Many inaccuracies have been noted with regard to the number, size, location, and use of the tanks.
- Most of the tanks are more than 25 years old, which increases the risk of tank failure and a release of hazardous materials.
- Several tanks are located within environmentally sensitive areas.
- No tanks were removed when the school department converted their heating systems to natural gas.
- Thousands of gallons of fuel have been found to be abandoned in place with the tanks when the energy conversion occurred.
- Past tank management practices represent multiple violations of state and federal tank management requirements.

V. Actions Taken:

To the best of our ability, we have identified the number and location of tanks believed to be present at local schools. So far we have removed three underground storage tanks from school property. The two sites which were found to be contaminated have been remediated and resolved. In the summer of 1998, we plan to remove six underground storage tanks from four local schools. We anticipate that this effort will also involve additional release abatement measures.

Lessons learned:

1. ***Local tanks records are often inaccurate or incomplete.*** We found many discrepancies when comparing written information with on site piping and structures. Be sure to conduct a comprehensive evaluation prior to initiating tank removal activities. Also, be prepared to respond to the discovery of 'new' previously unknown tanks.

2. ***Remove the contents from all tanks prior to abandonment.*** Failure to remove the contents prior to abandonment can allow the tank to become a perpetual source of contamination should it leak. In addition, this is a waste of money because you have paid once to obtain the heating oil for heating purposes and you will pay again to dispose of this material as a hazardous waste when you remove the tank.

3. ***Be sure to review the records and seek verification.*** Our effort was seriously delayed because several key individuals decided to accept statements reporting that all the tanks had been removed without consulting existing documentation or reviewing site conditions. Be diligent and thorough so that you can avoid a very costly problem.

Tips and Suggestions:

1. ***Always check the contents of your tanks before initiating removal actions.*** Pre-planning can make the budgeting and removal process easier. This can also help you prioritize your efforts.

2. ***If your tank is found to contain materials, then have the contents removed to eliminate the potential for additional materials to be released from the tank.***

3. ***Learn and familiarize yourself with state and local tank regulations as well as sensitive environmental receptors in your area.***

4. ***Establish a system to monitor and upgrade/remove your aging tanks as a means to prevent a costly release.***

Resources:

Prior to initiating a tank removal effort, I recommend that you seek the advice and assistance of your local fire department as well as state and federal environmental agencies. They can inform you about local regulatory requirements as well as the availability of grants designed to assist these efforts.

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Chemical Management
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Formaldehyde
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Chemical Fume Hoods
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Hazards By Department
Emergency Response
Ceramic Kilns
Underground Tanks
Classroom Lasers
Sanitary Drains

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Lasers

I. The Issue:

As our use and understanding of lasers increases so does the likelihood that you will find a laser in the classroom. This increased availability may also promote complacency with regard to the safety hazards posed by a laser as their use becomes more common place. A key point to remember is that all lasers have the potential to cause serious harm. No laser is risk free. Injury can occur as a result of equipment malfunction or mishandling. As a result, all lasers should be handled with care and respect to prevent accidental injury.

II. Observations made:

We did not actively investigate the number and types of lasers present in the school department, but instead stumbled across a serious laser safety hazard in the high school science department. The department possessed a low energy Uniphase class II laser (maximum power of less than 0.95 milliwatts) that is generally considered eye safe. This designation means that the unit is considered to be safe for use without protective safety glasses. Our laser has been used primarily for demonstration purposes by the faculty. Unfortunately, one staff member took the demonstration process too far by pointing the beam directly into his eyes. The intent of these demonstrations were to show that not all lasers were immediately dangerous. This practice was contrary to the conventional standards of laser safety and the recommendations of the manufacturer who stated that the beam should be treated with caution and no one should view the beam directly.

III. Problems or concerns noted:

- As a result of these demonstrations, the instructor may have caused long-term damage to his eyes.
- These demonstrations may have given students the wrong impression regarding the risks associated with the use and handling of lasers.

IV. Actions taken:

We addressed this problem by reviewing general laser safety and the operator's manual for the laser with the science faculty and school

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administration. During this discussion, we also reviewed the potential long-term health effects and possible workmen's compensation issues associated with these demonstrations. As a result, the laser to eye demonstrations have been discontinued.

Lessons learned:

1. Check to see if your school department owns or operates a laser. Review all uses and demonstrations. Do not assume that all uses are necessarily safe or appropriate. Check to make sure the unit is secured when not in use to prevent inappropriate student use.

2. Train or review laser usage with your staff to ensure everyone understands the safe and appropriate use of the devices available.

3. Depending on the power or type of laser(s) you have in your inventory, you may need to register the unit with your state health department.

4. All lasers should be treated with care and respect as a means to prevent accidental injury.

Resources:

During our evaluation, I relied upon the services and expertise of the Massachusetts Department of Public Health Radiation Control Program. I encourage you to consult with your state health department when pursuing a similar investigation.

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Chemical Management
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Mercury Management
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Sanitary Drains

I. The Issue:

Historically, many have thought of sinks and drains as an ideal spot for disposing of unwanted items... including chemicals. Unfortunately, improper disposal of chemicals via sanitary drains can create a number of health and safety issues. First, using laboratory sinks for chemical preparation and disposal as well as for food preparation and utensil cleaning can result in cross contamination and chemical ingestion. Also, the disposal of chemicals into sanitary drains can adversely impact indoor air quality if the materials collect in drain traps and slowly release emissions. Another point of concern is related to the disposal of water reactive materials to sanitary drains. These substances can react with water to release a gas or heat and energy. Depending upon the material, it may generate a noxious gas (e.g. chlorine based pool cleaners) or be explosive in nature (e.g. aluminum phosphide or sodium metal). A final concern is related to what environmental impact occurs where the drain ultimately discharges. Does the drain discharge to an on-site septic system which may create a local contamination problem or will the discharged material travel a distance and combine with other chemicals at a waste water treatment plant or receiving waters. One Massachusetts high school has been labeled a hazardous waste disposal site as a result of chemical wastes being discharged into laboratory sinks which resulted in the contamination of the sanitary leachfield serving the school. This problem could have been worse if the school had also been using an on site well for drinking water.

In light of these concerns, it is necessary that we prevent the introduction of hazardous chemicals into sanitary drains and that we establish appropriate measures for managing hazardous waste. Otherwise catastrophic environmental or personal injury may occur.

II. The approach taken:

While inspecting the high school science area in 1992 and 1993, I routinely noted that the staff appeared to be using the sinks for solution preparation and chemical disposal. I also noted that much of the science staff used the sink in the central preparation area for both chemical handling and food preparation. These observations suggested that the staff was using improper hazardous waste management practices. In addition, the use of the sink in the central preparation area for both chemical handling and food preparation increased the likelihood of cross contamination and accidental chemical ingestion by the staff.

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Routine and repeated observations involving improper chemical handling around the science department sinks prompted the Board of Health to review existing records to determine what disposal procedures and hazardous waste disposal records existed. As a result, we discovered records dating to 1971 suggesting that the high school science department had routinely disposed of its hazardous waste via the sanitary sewer system. In addition, the science department had on occasion contacted several municipal departments regarding the flow rate and outfall of the municipal sewer system with the intent of optimizing the dilution of the materials discharged to the sanitary sewer. No records were available to indicate how the hazardous waste generated by the school or science department had been managed prior to 1993. These findings suggested that the staff may have disposed of chemicals via the sanitary sewer system.

As a suburban community located in close proximity of metropolitan Boston, Burlington is a member of the Massachusetts Water Resource Authority (MWRA). The MWRA is a quasi-governmental regional agency responsible for providing drinking water and treating sewerage for many communities in eastern Massachusetts. In Burlington, the MWRA is responsible solely for the treatment of sewerage. In the 1980's, the treatment and inspection methods of the MWRA were deemed inadequate and antiquated when the Boston Harbor was identified as one of the most heavily polluted harbors in America. Much of the contamination discovered in the harbor was believed to be the result of chemical contaminants being discharged into the sanitary sewers and then into Boston Harbor via the MWRA system. In response to these problems, the MWRA has adopted some of the most stringent discharge limitations for organic solvents and heavy metals. Using this information, we established local discharge standards consistent to or more stringent than those established by the MWRA. Next, we trained and informed the staff with regard to the existing discharge requirements. At the same time, we also assisted the school department with the establishment of new hazardous waste management procedures.

During follow up inspections conducted in 1994, we continued to find evidence that the staff might still be using the sanitary drains for chemical disposal. After lengthy discussions, it was learned that the some of the staff learned that the MWRA did not actively permit and regulate schools and as a result a number of the staff members incorrectly believed that the discharge limits established by the MWRA did not apply to the school. In order to end this debate, the Board of Health adopted an active enforcement policy with regard to the local discharge standards. The risk of incurring a $200 fine per violation per day of non-compliance provided the motivation for most teachers to significantly reduce the volume of hazardous waste being discharged via the sanitary drains at the high school.

III. Observations made:

Random inspections of the high school science department conducted between 1992 and 1994 resulted in the routine observation of chemical containers stored in sinks or materials being emptied in sinks. In addition, the laboratory sink located in the central preparation area and adjacent to the department office was frequently found to be used for chemical preparation and food handling. These practices suggest that inappropriate materials may have been discharged via the local sanitary sewer. The possibility also existed that cross contamination could have occurred between chemical containers and eating utensils and resulted in accidental chemical ingestion.

A review of historical records suggested that chemical disposal via the sanitary drains may have been common practice by the high school science department during the 1970's and 1980's. In 1971, the high school science department contacted the Board of Health and the Department of Public Works requesting information regarding local sewer flow rates, volume, treatment methods and discharge points. The intent of the author was to maximize the dilution of the materials discharged via the laboratory drains. In 1986, this practice went awry when one pound of water reactive aluminum phosphide detonated when disposed of via a laboratory sink. The resulting explosion destroyed the laboratory plumbing and created two holes in a cinder block wall. When the aluminum phosphide violently reacted with water it also generated highly toxic phosphine gas, a basic chemical warfare agent. The generation of this material prompted the local hazmat team to evacuate the school.

A survey of local records failed to uncover any documents recording the disposal of hazardous waste prior to 1993. This discovery raised concerns as to how chemical wastes had been historically managed by the school department staff.

Training and informing the staff with regard to proper chemical management practices and local sewer discharge practices initially met with limited success. However, active local enforcement provided the motivation necessary to promote a significant reduction in the amount of hazardous chemicals entering the sanitary sewer at the school.

IV. Problems or concerns noted:

- Evidence of poor chemical hygiene and possible chemical contamination of eating utensils was common in the science department.

- No records were available prior to 1993 to indicate how hazardous waste had been routinely managed by the school department.

- Inspection of the drains and plumbing in the science area indicated that a variety of debris and residue were present in lab drains which may become potentially reactive or create indoor air quality issues.

- The risk of enforcement action was needed to motivate the staff to discontinue inappropriate chemical handling activities in laboratory sinks.

V. Actions taken:

A. Established hazardous waste disposal procedures. Almost at the outset of this review, it became apparent that the lack of guidance regarding the management and disposal of hazardous waste may have played a role in the staff developing their own procedures. As a result, new formal practices and procedures were created to eliminate confusion and to ensure the proper management and disposal of chemical waste generated by the school department.

B. Trained and informed the staff of local discharge requirements established by the regional water and sewer authority. This exercise involved a discussion of the types of materials that could be discharged via the lab sinks as well as a discussion of the materials that could not be discharged and had to be containerized for disposal as hazardous waste. A review of newly established hazardous waste collection and disposal procedures was also provided at this time.

C. Risk of enforcement promoted the adoption of new procedures. Inappropriate chemical handling was noted even after the creation of new hazardous waste disposal procedures and the completion of additional training. This prompted the Board of Health to seek enforcement assistance from the MWRA and the Massachusetts Department of Environmental Protection. Both agencies expressed concern but also indicated that they did not actively review or regulate schools and therefore would not take action. As a result, the Board of Health adopted a local policy of fining personnel caught discharging hazardous waste via sanitary drains. This policy provided the motivation for the staff to alter its chemical handling practices.

Lessons learned:

1. ***Do not assume that everyone practices good chemical hygiene.*** We frequently noted that the staff prepared stock solutions and disposed of chemicals in the same sink and bench top areas that they used for preparing their lunches and cleaning eating utensils. Even after being informed of the risk of chemical cross contamination and the possibility of accidental chemical ingestion, the staff still continued to resist changing their practices.

2. ***If you do not establish procedures for managing hazardous waste then your staff will probably develop their own - legal or not.*** During discussions many staff members indicated that they had never been formally directed how to manage or dispose of their excess chemistry. As a result, the staff either placed the material in long term storage in the classrooms and laboratories or managed the material as they felt was appropriate. This resulted in the accumulation of a large volume of unlabeled and potentially hazardous substances in the science area as well

as the improper disposal of an unknown quantity of materials.

3. ***The adoption of new procedures and methods does not mean that the problems will automatically be resolved.*** Training and follow up inspections will be necessary. In addition, disciplinary action may be required to modify entrenched habits and behavior.

Tips and suggestions:

1. ***Develop a non-toxic or less toxic curriculum to eliminate or alleviate this problem.***

2. ***Establish hazardous waste collection and disposal procedures to ensure the safe and legal handling of these materials.***

3. ***Train and inform your staff with regard to the proper handling and management of chemicals.***

4. ***Post warnings/advisories around sinks and drains prohibiting the disposal of chemicals via the sanitary sewer system.***

5. ***Be prepared to take enforcement or disciplinary action to change old habits.***

6. ***Consult local sewer regulatory authority to determine what discharge standards apply for your location.***

Resources:

The U.S. Environmental Protection Agency and the Massachusetts Department of Environmental Protection provided me with general guidance used during the initial phase of this review. As the local regulatory body with primary jurisdiction over the sanitary sewer system, the Massachusetts Water Resource Authority rapidly became my main source of information and guidance. Prior to initiating a comparable review, I recommend that you consult your local sewer authority or publicly owned waste water treatment plant for guidance and information regarding local discharge requirements, procedures, and assistance programs.

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