HELPFUL HINTS FOR OPERATING SCHOOLS

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ABSTRACT

Effective operation of school buildings in periods of both total and partial occupancy requires active management and proactive maintenance. Prevention, response, policy implementation, and adequate training are the main elements of a successful operations program.

This paper will discuss helpful hints that schools can use to maintain a proper building environment and save energy at the same time. Two case studies will also be included. The first is the TEAMS program, developed by Carrollton-Farmers Branch ISD. The second is an effective energy policy and program employed by Hurst-Euless-Bedford ISD. The experience of the authors gained through assisting Texas school districts will also be shared.

MOISTURE

Sources and Causes

Moisture in schools comes from a variety of sources. The most common are roof and plumbing leaks, improperly sealed building envelope, condensation, and excess humidity. Condensation is common especially in humid climates. It usually forms when warm air contacts cold surfaces. Frequent objects on which condensation collects are windows, pipes, and exterior walls. Moisture laden air, also ever-present in humid climates, enters buildings through open or leaky doors and windows causing excessive humidity. Leaks from roofs, windows, walls, and plumbing bring unwanted water into school buildings. In some instances amounts can be sufficient to cause damage. When moisture does accumulate in a building, modern, tightly sealed construction may not allow it to escape easily. Delayed or insufficient maintenance due to budget and other constraints often exacerbates moisture problems. Preventing excess moisture is much easier than removing it. Designers, custodians, kitchen staff, maintenance personnel, grounds workers, facilities managers, and occupants all have a role in controlling moisture.

Moisture can also come from beneath a building. For facilities that have crawl spaces, removal of moisture is important. Therefore, do not let water stand underneath buildings. Facilities in humid climates should have adequate underfloor ventilation, creating a negative pressure in crawl spaces.

Benefits of Control

No matter what the source, eliminating excess moisture benefits both owners and occupants. Monitoring and limiting moisture are beneficial to occupant comfort, and essential in controlling molds and bacteria. Water can also damage wood, carpet, ceiling tiles, insulation, equipment, furnishings, books, and other items. Therefore, preventing or quickly repairing building and plumbing leaks protects contents from damage.

Prevention

Excess moisture in the air gives occupants a sensation of dampness and stuffiness. Since humidity is a measure of moisture present in the air, lower humidity readings indicate a reduction in the air's moisture content. Ideally building humidity levels should be between 30% and 60%. At readings less than about 30%, wood items such as floors and furniture tend to dry out. Low humidity levels also contribute to static electricity, which can cause damage to sensitive electronic components. Skin, throat, and respiratory irritation are also more likely when indoor moisture levels are too low. On the other hand, humidity readings above 60% can cause unwanted problems too. Higher moisture levels may attract bugs, accelerate bacteria and mold growth, and contribute to the formation of condensation on walls, windows, and other cold surfaces.

Limiting the introduction of moist outside air helps lower indoor humidity. Current building codes set outdoor air requirements at 15 cfm per student in most applications. So, in an elementary school classroom with 23 students, 345 cfm of outside air is required. On a humid spring day, outdoor air could bring in a substantial amount of water in the form of vapor. Add this amount to the three pints or so daily given off by the average person and one can see how

a classroom quickly becomes moisture laden. Therefore, HVAC design should ensure dehumidification of outside air introduced into buildings. ASHRAE Standard 62, which tripled the amount of outside air required in classrooms, has resulted in additional air conditioning loads. Consequently, more supplementary equipment is needed to pre-treat the incoming air.

To limit the introduction of moist outside air, consider keeping outside air dampers closed during morning air conditioning startup. This can be done until occupants' arrival, which signals the need for outside air. Also, in rooms with no occupants, such as server rooms, a minimal amount of outside air is needed – just enough to keep the space at a positive pressure to prevent infiltration of dust, etc.

Activities that produce steam such as cooking, dishwashing, and showering also raise humidity levels. Therefore, areas including locker rooms and kitchens must be adequately ventilated. Proper design utilizing an adequate number of fans with the correct ventilation rates is essential to moisture removal. Kitchen staffs should turn on exhaust fans when cooking begins and leave them on until dishwashing and cleaning are completed. Exhaust fans in locker rooms should run until all have showered, mist is no longer present, and the area is dry.

Carpet and floor cleaning is another source of moisture indoors. Wet surfaces, especially carpet, are ideal environments for mold growth. To reduce excess moisture, use the minimum amount of water adequate for the job at hand, and make sure that areas are dried as quickly as possible. Also, keep air conditioning fans operating until surfaces are completely dry. Use portable dehumidifiers in addition to air conditioning. Finally, utilize extraction vacuums specially designed for water removal. Operate these machines at settings to reduce the amount of water introduced and speed up the cleaning process. In kitchens, use alternatives to the "hose-down" method of cleaning. Overall, employ procedures that minimize water introduced into the building. After cleaning, do not leave standing water or wet surfaces.

The authors have observed that cleaning crews in some schools sometimes create moisture and mold problems during the summer. They clean carpets using too much water, turn off all air conditioning, and then leave the building for the remainder of the summer. In contrast, cleaning crews in effectively operated schools tend to use minimum amounts of water and operate extractors and air conditioners for moisture removal. In fact, air conditioning should never be turned off completely, just set to a higher temperature. They never just turn off the air conditioning and walk away. At these schools, personnel know how to properly operate air conditioning for energy efficiency and humidity control.

Spills and leaks release additional moisture into buildings. Spills may occur at any time during normal operations. Take care to prevent spills when using buckets, etc. of water. Leaks can come from the building envelope as well as broken pipes or overflowing plumbing fixtures. Walk-in chases can expedite inspection of piping. To prevent problems from these sources, conduct periodic inspections in search of deterioration and damage that could potentially become problems. Outdoors look for clogged or broken roof drains, gutters, or downspouts; rotted, damaged, or rusting building materials; cracked foundations; inadequate seals around roof penetrations; and damaged pitch pans. Check irrigation sprinklers and make sure that they are not letting water accumulate near buildings. Also keep dirt below the brick ledge and ensure that weep holes are clear. Indoors, ensure that drain pans are emptying properly, drain lines are not clogged, condensate is not forming on piping, and that there are no visible plumbing leaks at fixture drain and supply lines. Good access to these components aids in examining them for proper operation.

Condensation is another form of moisture in buildings. Preventing it requires measures to reduce contact between warm humid air and colder surfaces. Selection of the proper building materials as well as correct operation of air conditioning systems mitigates condensation formation. As condensation often forms on windows, the use of double-pane windows to reduce the temperature difference across the glass is often helpful. Adequate insulation in exterior walls and around cold water piping in interior spaces reduces condensation on these surfaces. Operating air conditioning systems to reduce humidity levels will aid in minimizing condensation formation.

Air conditioning systems should be left operating even during times when buildings are totally or partially unoccupied. Turning off air conditioning during the summer or holiday periods allows humidity levels to rise uninhibited, which can lead to increased insect infestation and/or mold growth. Room temperatures need not be kept at occupied levels. However, units need to run for the purpose of controlling humidity and preventing excessive temperatures. Air conditioners should be operated

when humidity readings exceed about 60%. This type of control can be achieved with the use of humidistats that monitor humidity levels and signal systems to start and stop to maintain desired levels. Also, avoid thermostat settings above approximately 82°F. Acceptable cooling setback temperatures can vary depending on local conditions, slightly higher in drier regions and slightly lower in more humid areas. At a minimum, air conditioning systems should be on several hours each day during unoccupied periods. Energy management control systems can be pre-programmed with applicable operating settings and modes for various times of year.

Proper operation of air conditioning systems prevents moisture buildup. Chillers and compressors should be left on when ventilating. For energy efficiency, some units have economizer modes that bring in and circulate unrefrigerated outside air. In hot and humid climates, found in much of Texas, most of the time this mode only serves to introduce moisture laden air into buildings. Likewise, running air handlers only to circulate air (during custodial work times, for example) without operating chillers or compressors floods schools with humid air. Also, chilled water supply temperatures should be kept at or below 45°F. Increasing the temperature is a strategy sometimes used as an energy saving measure; however, increasing the chilled water temperature can inhibit a system's ability to remove moisture from the air.

Response to Moisture Problems

As previously mentioned prevention is the best course of action where building moisture is concerned. However, excess moisture problems are to be expected occasionally. In these cases, the actions taken can make the difference between desirable and unfavorable outcomes. Proper assessment of the situation, cleanup, and corrective measures are all are very important.

If a moisture problem is suspected or actually found, first assess the situation. Try to determine the size of the problem, the types of materials that might be damaged, and the presence of mold. If the affected area is small and little or no mold is found, in-house custodial crews may well be able to handle the cleanup. However, outside specialists could be necessary if a sizeable area is involved or if large amounts of mold are found or suspected. Remember that molds may not be visible with a rudimentary inspection. Hidden molds can grow on or within materials without being noticed. Molds frequently inhabit such spaces as the backside of dry wall, top of ceiling tiles, underside of carpets, and inside of chases. If a strong musty or moldy odor is present, active mold should be suspected. Analysis of material or air samples can reveal the presence of mold spores.

Next clean the affected area if molds are not present. First, eliminate any standing water. Use extraction vacuums specially designed for this purpose to remove water from carpets, upholstered furniture, and hard floor surfaces. Discard any water-laden materials such as books, paper, ceiling tiles, and insulation. Wipe down non-porous surfaces like wood, plastic, and metal. Dry gypsum wallboard in place if it appears to be intact; if not, remove and replace it. Accelerate the drying process with fans, heaters, and dehumidifiers as appropriate. The key to lowering the probability of mold growth is to clean up water from spills and leaks within 48 hours (preferably less in most schools) after the incident.

If molds are present, then determine extent of the contamination. For small areas, in-house staff may be able to do the job. For any mold cleanup task, the Environmental Protection Agency (EPA) recommends the use of personal protective equipment. For contaminated areas larger than about 10 square feet, the EPA suggests considering the potential for worker exposure and calling in professionals with the proper equipment.

The Texas Department of Health is currently developing licensing and minimum performance standards for those doing mold assessment and cleanup. Under the proposed guidelines, workers performing cleanup where the affected area exceeds 25 contiguous square feet would require licensing.

DEMAND CONTROL VENTILATION

ASHRAE Standard 62 generally sets the amount of outside air required based on the expected number of room occupants. Demand control ventilation is an alternate method of establishing outside air requirements. Instead of anticipating the potential number of occupants, this approach utilizes CO_2 sensors to modulate outside air intake. As more people enter a room, the concentration of CO_2 increases. Sensors adjust dampers to provide more outside air when a CO_2 threshold level is reached. Conversely, less outside air is brought in when the amount of CO_2 present falls below the preset level. During occupied times dampers should never be fully closed. There should be a minimum open damper setting dependent on design conditions, but typically not lower than 7.5 cfm per person. CO_2 sensors can be installed at the time of system installation or as retrofit items.

MAINTENANCE AND TRAINING

An aggressive preventative maintenance program should be established for all air conditioning equipment, controls, plumbing systems, and the building envelope. Formal documentation giving specific procedures and assigning responsibilities is essential. Methods for equipment inspection and maintenance as well as testing and setting of controls for desired operation should be outlined. Each facility is unique, so develop plans and procedures taking into account local scheduling, operating, and climatic situations. Checklists that outline preferred procedures and methods are a good tool to prevent items from being overlooked.

Good maintenance includes keeping HVAC equipment clean. Coils, fan blades, and grilles all need to be kept free of dirt, dust, and debris. Dirty components can reduce airflow and diminish a system's capacity to cool properly and keep humidity levels in check.

Just as buildings are inspected and a report generated for the presence of asbestos, the same can be done for molds. Air samples can be taken to measure the concentration of molds in a building. Where mold quantities are found to be abnormally high, subsequent investigations by a qualified consultant can reveal their source and potential courses of remediation.

All members of the school's staff need to be aware of the building operations program, as all will have a role. Teachers and administrators must know how to correctly adjust thermostats in their areas, if present, for proper system operation and moisture control. The custodial staff will require training in proper cleaning methods. Kitchen personnel need to understand operating and cleanup procedures that prevent moisture buildup. Maintenance workers and grounds crews should understand how to conduct inspections to spot and correct potential problems. Custodians and maintenance personnel also should understand how to operate air conditioning systems. All too often the manuals are in an unopened box. Everyone ought to be shown how to recognize signs of high humidity, building envelope water leaks, and mold growth. They should be instructed regarding what, when, how, and to whom to report any problems.

ENERGY SAVINGS

Controlling moisture and saving energy can go together. Selecting properly sized air conditioning equipment contributes to both moisture control and energy savings. Units that are too large for their designated purpose do not adequately remove moisture from the air. They also consume more energy than smaller units, as increased size generally means higher energy consumption. Preventing moisture buildup by all of the means outlined so far means that humidity will more likely remain at proper levels. Therefore, less energy will be needed for moisture removal Also, as mentioned previously, proper insulation in walls and around piping helps prevent condensation. Adequate insulation in walls saves energy by reducing heat and cold transfer. Piping insulation also prevents unwanted heat loss or gain, depending on the contents of the piping. All of these measures together help minimize unwanted moisture buildup and reduce energy bills simultaneously. In essence, good operation plus quick responses to problems are the keys.

OBSERVATIONS

The authors have observed various practices and conditions that have contributed to poor indoor environments and decreased energy efficiency. These examples illustrate the importance of proper operating procedures and regular maintenance.

In mechanical rooms with unducted (free) returns air the following have been found stored:

- Weed eaters
- Gasoline cans
- Trash cans
- Mops
- Pesticides
- Molded bale of hay
- Buckets of dirty water
- Dirty garden hoses
- Dirty discarded air filters
- Parts (new and old)

At an east Texas elementary school substandard masonry work left small but noticeable gaps between bricks. Improperly installed windows and leaky roofs were also found. All these lapses in construction allowed moisture to enter the school. One noticeable consequence was peeling paint along exterior walls inside the building. A contractor was hired to correct the deficiencies, and the observed problems associated with excess moisture ceased.

An investigation to find the cause of high humidity levels in a west Texas school led to the discovery of several problems associated with poor maintenance. A layer of dust approximately 1/8-inch thick covered the cooling coils in the air handlers. This covering of filth inhibited airflow and decreased

the cooling capacity of the equipment. Also, fan belts driving the air handlers were so loose that they were barely making contact with the blower wheels. Finally, outside air dampers had been closed. Addressing each of these issues solved the high humidity problem at the school.

In another school moisture began condensing on interior walls. A subsequent search for the cause revealed that the chilled water temperature had been increased to 50°F. The raised temperature of the water decreased the cooling system's ability to remove moisture from the air. After the water temperature was reset to about 45°F, the condensation problem was eliminated.

The preceding examples illustrate the importance of proper operating procedures and regular maintenance. Following these helpful hints improves equipment performance and can create a healthier, more comfortable, and efficient building environment.

ASHRAE STANDARD 62 – AUTHOR OBSERVATIONS

Compliance with ASHRAE Standard 62, which increased outside air requirements for a typical classroom from five to 15 cfm per student, has resulted in significantly increased costs for schools. Before this tripling of the outside air required, most IAQ related problems observed by the author were caused by maintenance personnel completely closing outside air dampers. Owners throughout hot and humid climates have experienced greater first costs, increased maintenance expenses, additional energy expenditures, and more humidity problems since the revised ASHRAE standard was implemented. The author recommends that ASHRAE and code officials revisit the tripled outside air requirements for the following reasons: ASHRAE Standard 62 is not regionalized, significant disagreement and discussion exists within the engineering community and among owners concerning ASHRAE's tripling of the outside air, and there is no official ASHRAE documentation to support the 15 cfm requirement in hot and humid climates other than a general position paper. Lowering the 15 cfm rate to the range of 7.5 cfm per student would have a tremendous, beneficial impact on overall costs and problems.

CASE STUDIES

T.E.A.M.S.

T.E.A.M.S., which stands for Tools for Schools, Energy, Asbestos, Moisture Management, and Safety is a program implemented by the Carrollton-Farmers Branch ISD, north of Dallas. It is a comprehensive plan addressing all of these issues. The concept behind the plan is that these items are interrelated. As an example, improperly sealed doors would affect air quality, energy, and moisture control. Tools for Schools, dealing with indoor air quality, and Moisture Management are of interest in this discussion. Teachers are given a questionnaire about their classroom's overall condition. Questions are included regarding the presence of condensation on surfaces; leaks under sinks and in bathrooms; evidence of leaks on ceilings and walls; and musty or moldy odors. Teachers are to note the existence of any of these concerns as well as energy related items. A list and map of concerns is generated from responses received. The moisture management portion of the plan includes a program to repair leaks, inspect roof and building penetrations, and check site drainage. A map of problems found is generated from building inspections. The T.E.A.M.S. committee meets weekly to discuss and coordinate issues.

Hurst-Euless-Bedford ISD Energy Program

For more effective operation of their schools, the Hurst-Euless-Bedford (HEB) ISD, located between Dallas and Fort Worth, has adopted a comprehensive energy management program. The policy includes aggressive energy-saving operating practices, awareness measures, preventative maintenance procedures, and facility upgrade guidelines.
A summary of the HEB program:

- Operating practices
  - Centralization of scheduling requests for after hours air conditioning
  - Sleep mode for computer monitors
  - Personal refrigerator permit program
  - Timers on vending machines
  - Optimized air conditioning and heating startup
- Awareness measures
  - Implementing Watt Watchers program
  - Discussions about energy savings at faculty meetings, etc.
- Preventative maintenance procedures
  - Filter crew
  - Scheduled visits
- Facility upgrade guidelines
  - Energy efficient lighting
  - High efficiency HVAC
  - Energy management controls

From 1993-94 (school year) to 2002-03, overall square footage increased some 35 percent, but total

energy expenditures rose only about 16 percent. HEB ISD has dramatically reduced its energy consumption during the past two years. Electric consumption for the 2001-02 and 2002-03 school years was approximately 25 less than in 2000-01, despite additions totaling some 78,000 square feet. Expenditures for electricity in 2001-02 and 2002-03, respectively, were down 45% and 34% over 2000-01. Over 50% of the savings was attributable to conservation efforts, with the remainder the result of lower rates resulting from deregulation.

ADDITIONAL INFORMATION

Molds

Molds are fungi – single-celled organisms that have existed for centuries and produce microscopic spores for reproduction. The spores can enter buildings through open doors and windows, cracks in walls, or by attaching to people or objects. Essential elements for mold growth include proper temperature, food sources, and adequate moisture. Typically schools also have abundant organic food sources such as paper, carpet, wood, and food waste. Molds gradually destroy any of these substances they feed and grow on. Water is also critical to mold growth, for without it they remain dormant. Moisture control is the key to mold control. Completely eliminating mold spores from a building is not practicable. The best approach is to try to control them, through minimizing indoor moisture.

Bacteria

Bacteria are one-celled organisms averaging about one-millionth of a meter in diameter. They are so small that hundreds of thousands of them could fit on the end of a pencil. Bacteria live all around us - in the air, soil, and water, on plants, and in animals. Our bodies are home to many varieties of bacteria.

Most bacteria are friendly, playing key roles in beneficial activities like waste and garbage decomposition, carbon dioxide production, digestion, fermentation, crop nutrition, and toxic waste cleanup. Disease-causing bacteria are usually those picked up from external sources such as sick people or animals and contaminated food or water.

To grow and reproduce, bacteria need water and a source of food. Most everything we eat can be considered food for bacteria. While there are cold loving and heat-loving varieties, most bacteria responsible for disease grow at more moderate temperatures, 50°F to 100°F. As room temperature falls within this range, eliminating moisture and food supplies are the most realistic ways to control environmental bacteria.

SUMMARY

Indoor air quality and comfort, moisture control, proper operating and maintenance practices, and energy savings are all related. Improper operating and maintenance procedures can lead to comfort issues, diminished air conditioning systems performance, facilities damage, and energy waste.

Written guidelines, especially regarding summer operations and cleaning procedures, are helpful in school facilities. These guidelines should incorporate best practices for controlling moisture, keeping indoor comfort, and maintaining equipment. Training custodial and maintenance personnel to supplement written guidelines is absolutely required.. Both documentation and training should be kept up to date to provide maximum benefits.

ASHRAE Standard 62 tripled the amount of outside air required in school classrooms. The increased financial burden to schools in initial costs, maintenance expenses, and energy costs; the large number of problems throughout hot and humid areas; plus the lack of adequate documentation showing the benefits of additional outside air lead the authors to suggest reconsidering the standard on a regional basis.

Finally, these hints are provided to assist in managing and operating school facilities. The information presented is intended to be informative but obviously cannot anticipate every situation or circumstance. Neither are these suggestions intended to advise replacing or altering current maintenance and operational procedures, but to share the experience of the authors.

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