


NORTHEAST-CHPS OPERATIONS & MAINTENANCE GUIDE APRIL 2010

Strategies for creating green, healthy & energy efficient existing buildings

The High Performance Schools Exchange
Northeast Energy Efficiency Partnerships
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Preface

A Companion Piece to Northeast-CHPS

The Northeast-CHPS Operations and Maintenance Guide is a companion piece to the Northeast-CHPS Protocol. The Protocol provides a set of guidelines for the construction and renovation of K-12 schools in a manner that provides for enhanced learning environments, energy efficiency, and low environmental impact. The Protocol is, in part, based on the Massachusetts Technology Collaborative's High Performance Schools Guidelines (MA-CHPS), which were in turn based on CHPS, Inc. Guidelines. Northeast Energy Efficiency Partnerships (NEEP) has tailored Northeast-CHPS to the climate zones and school construction needs of the states in the Northeast, primarily Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. New York maintains a state specific version of CHPS.

Above all, a high performance school provides an environment that enhances the primary mission of public schools: the education of future citizens. Northeast-CHPS provides guidelines for the construction of new schools, the renovation of existing schools, and the operations and maintenance of all schools.

CHPS Best Practices Manual

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Codes and Regulations

State, local, and federal governments maintain a collection of codes and regulations that apply to the construction and operation of public schools. Northeast-CHPS does not attempt to present or replace any regulations or code requirements. All relevant codes and regulations should be adhered to and the adoption of recommendations presented in this guide should be considered as enhancements that improve the educational environment beyond what is required by the appropriate codes and regulations.

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Introduction

The purpose of the Northeast-CHPS Operations and Maintenance Guide is to provide guidance to school districts on developing and maintaining procedures that ensure the continued operation of school facilities in a manner consistent with the goals of Northeast-CHPS. High performance schools provide high-quality learning environments, conserve natural resources, consume less energy, are easier to maintain, and provide an enhanced community resource. However, they will only continue to perform at these levels if proper operational and maintenance procedures are followed.

Although this guide is a companion piece to the Northeast-CHPS Protocol, its usefulness is not limited to schools built or renovated to a high performance standard. Most of the practices discussed in this guide, adopted where appropriate, will assist in improving the operational environment of any school facility, regardless of age.

The Guide contains O&M procedures that will help schools reduce their operating costs, as well as lead to healthier indoor air, improved student and staff comfort, reduced water consumption, improved environmental stewardship, and overall improvements in the learning environment. O&M procedures targeted at energy efficiency can save 5 to 20 % on a school‘s energy bills. These savings can total up to hundreds of thousands dollars annually, and many can be achieved at no to little cost.

This Guide was developed with input from and at the request of local stakeholders, ranging from facilities managers to efficiency program administrators. The Northeast High Performance Schools Exchange intends to update this guide periodically as new O&M strategies become available. We encourage continuous feedback from practitioners to ensure that the Guide is a useful and comprehensive tool for Northeast school districts.

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I. Establishing Operations and Maintenance Policies

Operating and maintaining school facilities to a high performance standard requires a coordinated, integrated process that provides guidance for the multitude of individual items that facility staff need to address. The establishment of an overall operations and maintenance policy is an important step in achieving high performance results.

Establishing an Operations and Maintenance Advisory Committee

District leaders who institutionalize high performance are not just operating better schools; they are protecting student health, improving test scores, and lowering the district's operating expenses. It is recommended that the school district create a high performance operations and maintenance (O&M) advisory committee to oversee the implementation of an integrated O&M approach and that provides guidance for adhering to standards that promote the overall goals of Northeast-CHPS, and provide for a safe, healthy, and efficient educational environment.

The established committee should include representatives from the facilities, administrative, and educational staffs in order to address all relevant concerns. High Schools should also encourage student participation in the committee, and consider offering academic credit for constructive participation. A representative of the school board and/or a community sustainability committee may also prove valuable. The O&M advisory committee should be charged with guiding and executing the recommendations presented in this guide.

Developing a Policy for the Efficient Joint Use of the Facility

The most successful schools have a high level of parent and community involvement. School districts should support the sharing of spaces for neighborhood meetings, recreational activities, adult education, and other community functions that can take place in a safe and secure environment. School districts should give careful thought to the types of programs, services, and facilities they currently offer, and look for opportunities to expand such offerings (e.g., library services, recreation services, meeting space, space for special events, etc.).

Joint use of recreational space is a growing trend across the country. Schools are used by a variety of community organizations for a variety of recreational purposes. Use of school playing fields by the local recreation department allows the community to optimize resources dedicated to community recreation and to share costs with other municipal departments.

Establishing an Indoor Environment Management Plan

Implementation of the U.S. Environmental Protection Agency's (EPA) Tools for Schools program or an equivalent indoor health & safety program provides valuable guidance related to indoor air quality. For proper implementation, the school district should designate a trained staff person as the point of contact for the EPA Tools for Schools program or its equivalent.

EPA's Tools for Schools program is designed to identify, address, and prevent indoor air quality problems in schools. The prevention and comprehensive planning for indoor air problems is more effective and far less costly than crisis-reaction approaches. The Tools for Schools kit provides a basic set of operations and maintenance guidelines that will help prevent indoor air quality (IAQ) problems in schools. It establishes responsibilities and clear communication channels so that indoor air problems can be prevented and problems can be quickly identified and solved. In addition, the Tools for Schools system can be used to address other environmental health and safety conditions that arise.

Resources

EPA, Region I Environmental Protection Agency, Northeast office in Boston, Massachusetts, phone: (888) 372-7341: http://www.epa.gov/iaq/schools

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Develop and Implement a Master Maintenance and Staff Training Plan

All school systems should have a master plan for the maintenance of all equipment, the training of staff, and a process for assuring that future additions and renovations adhere to high performance standards. The plan should include an inventory of all equipment in the new or renovated school and its preventive maintenance needs. The inventory should cover at least the following systems:

- ❑ HVAC
- ❑ Plumbing
- ❑ Non-HVAC mechanical systems
- ❑ Lighting
- ❑ Building control systems
- ❑ Life and safety systems
- ❑ Interior finishes
- ❑ Roof systems
- ❑ Switchgear

The plan should address the preventive maintenance needed including: staff/vendor time and materials costs for each maintenance task, a schedule for these tasks, and a clear definition of who is responsible for performing the task, as well as the overall management of maintenance activities.

Ongoing staff training in the maintenance and operation of the inventoried equipment should be an integral part of the plan and must include provisions for expanding the plan to include any school additions and/or renovations.

Regular maintenance and staff training are critically important to the operation and performance of schools. Every district has unique maintenance needs, but districts should invest sufficient staff and resources to ensure that the school‘s building systems continue to operate as they were designed and that newly added equipment through future additions and renovations are properly maintained.

High performance schools are not maintenance intensive. However, all buildings and building systems require preventative – not deferred – maintenance if performance goals are to be met.

Master plans should include:

- ❑ Regularly scheduled preventative maintenance tasks over the lifetime of the building system or equipment. These tasks include cleanings, calibrations, component replacements, and general inspections. A commissioning plan and the required maintenance documentation is an excellent starting point and reference for developing the maintenance plan. The plan should include staff/vendor time and materials budgets for each maintenance task and clearly define who is responsible for performing the task,

as well as the overall management of maintenance activities.

- ❑ An ongoing training plan for staff in the operation and regular maintenance of all building systems.
- ❑ Provisions to incorporate newly added equipment and systems that result from equipment replacement, school renovations, and additions.

Resource

Facility Operating Plan Template from Vermont Superintendent's Association: This template facilitates the creation of an operating plan to properly manage buildings for efficiency and educational atmosphere for Vermont schools.

http://www.vtvsa.org/school-energy-management-program.php

Train and Certify Facilities Personnel Through a Comprehensive O&M Training Program such as the Building Operator's Certification Program

The Building Operator Certification (BOC™) is a nationally recognized training and certification program that focuses on practical skills improvement for facility operators. The program was developed by the Northwest Energy Efficiency Council and the courses are taught in the Northeast by an experienced group of instructors with practical experience in their subject matter.

Independent evaluation research shows that BOC certified operators are saving money and energy in their facilities. BOC operators apply concepts learned in training and undertake measures such as large energy conservation projects and IAQ improvements. Average annual per participant energy savings are estimated by this research to be 172,000 kWh per year, equivalent to $12,000 annually at national average electricity rates.

BOC participants earn certification by attending training and completing project assignments in their facilities. Upon successful completion of the course, operators have learned techniques that will assist with operating facilities in a manner that promotes energy conservation, indoor air quality, and enhances the environmental health and safety of building occupants.

Two levels of training and certification are offered:

The Level I course series offers seven one-day classes with Level II offering eight one-day classes. Course series consist of classroom training, project assignments completed at the facility, and in-class exams administered at the end of each day of training.

BOC Level I Courses Include:

- ❑ BOC 101 – Building Systems Overview
- ❑ BOC 102 – Energy Conservation Techniques
- ❑ BOC 103 – HVAC Systems and Controls
- ❑ BOC 104 – Efficient Lighting Fundamentals
- ❑ BOC 105 – Operation & Maintenance Practices for Sustainable Buildings
- ❑ BOC 106 – Indoor Air Quality description
- ❑ BOC 107 – Facility Electrical Systems

BOC Level II Courses Include:

- ❑ BOC 201 – Preventive Maintenance & Troubleshooting Principles
- ❑ BOC 202 – Advanced Electrical Diagnostics
- ❑ BOC 203 – HVAC Troubleshooting & Maintenance
- ❑ BOC 204 – HVAC Controls & Optimization

Supplemental Level II Courses:

- ❑ BOC 210 – Advanced Indoor Air Quality
- ❑ BOC 211 – Motors in Facilities description
- ❑ BOC 212 – Water Efficiency for Building Operators
- ❑ BOC 213 – Mastering Electric Control Circuits

BOC Tuition & Funding Opportunities

BOC Level 1: $1,375 per participant

The registration fee includes 74 hours of classroom instruction, seven course handbooks, facility project assignments, and certification recognition materials.

BOC Level II: $1,375 per participant

The registration fee includes 61 hours of classroom instruction, seven course handbooks, facility project assignments, and certification recognition materials.

Course Discounts and Tuition Reimbursement

Many sponsoring utilities and energy efficiency programs offer financial assistance for completing the BOC programs. Current program offers include:

Efficiency Maine: http://www.efficiencymaine.com/education_programs.htm

Maine resident discounted BOC tuition fee:

$850 for private sector or federal agency facility personnel

$550 for K-12 public school facility personnel

Long Island Power Authority: http://www.lipower.org/commercial/efficiency/commercial.html

Discounted tuition for LIPA customers is $699.

Vermont Customers (Efficiency Vermont & Burlington Electric Department): http://www.efficiencyvermont.org/pages/Business/

Fee for registrants residing in Vermont – $1,075

Cape Light Compact: http://www.capelightcompact.org/

Tuition Rebates available ranging from $300 to $1,375. Contact efficiency@capelightcompact.org for details on eligibility and rebate process.

Other BOC Sponsors: Tuition rebates up to a maximum of $300 are available for facility managers in the territories of other BOC sponsors. Contact the BOC for details: http://theboc.info/index.html

Other Building Operator Training

Many state agencies and utility companies periodically offer training sessions that are relevant for building operators. These trainings are often an introduction to the BOC, or are termed "BOC Light." Consult the resources listed below for upcoming training opportunities.

Resources

BOC Web site: http://theboc.info/index.html

BOC Informational Webcast: http://theboc.info/infowebcast_form.html

BOC Training Schedule in the Northeast: http://www.theboc.info/ne/schedule_ne.html

State of Rhode Island Training Programs: http://www.energy.ri.gov/programs/outreach.php

Public Service of New Hampshire Workshops:
http://www.psnh.com/Business/Commercial/Workshop_frame.asp

Efficiency Maine Training Programs: http://www.efficiencymaine.com/education_programs.htm

State of Connecticut Training Programs: http://www.ctenergyinfo.com/index.htm

Massachusetts Facilities Administrators Association: http://www.massfacilities.org/

NSTAR Electric Training Programs:
http://www.nstar.com/business/energy_efficiency/seminars/default.asp

National Grid Training Programs:
http://www.nationalgridus.com/masselectric/business/energyeff/3_training.asp

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Specifying Equipment Performance Levels (ENERGY STAR) for the Replacement or Addition of Equipment and Appliances

The energy use of a school is not only associated with the building systems (HVAC, lighting, etc.), but also with the supplementary equipment associated with typical school operations. So called "plug loads" have become a rapidly growing portion of school operating budgets because of the reliance on computer systems and other equipment. Choosing efficient equipment has a large impact on energy consumption and costs.

Establishing a written policy that all newly purchased equipment and appliances to be used in the school be ENERGY STAR compliant (in any product categories where there are applicable ENERGY STAR categories) will ensure that plug loads are kept to reasonable levels. Additionally, the policy should prohibit the purchase of low efficiency products, including incandescent task lights, halogen torchieres, and portable electrical resistance heaters.

The ENERGY STAR program was established to provide accuracy and consistency in energy usage ratings and to encourage the purchase of efficient equipment. The program maintains a database of compliant manufacturers and products including computers, monitors, copy machines, water coolers, printers, scanners, refrigerators, ceiling fans, and washing machines. In many cases, equipment that exceeds ENERGY STAR's efficiency requirements is available and should be considered.

Plug Loads - EnergySmart™ Schools (see Resources): Office, instructional, vocational, and cleaning equipment, as well as personal appliances brought from home, are considered plug loads in schools and can account for up to 25 % of the electricity consumed annually. Most of this equipment is left on all day. To conserve energy from these loads, O&M procedures should

include plug load management approaches. If the average computer is left running, it will consume approximately $285 of electricity over its lifetime (depending on the electricity rate). Monitors consume approximately two-thirds of this energy.

Resources

ENERGY STAR: http://www.energystar.gov/

Plug Load Action Plan Template (EnergySmart Schools): http://apps1.eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess_plug-loads-template.pdf

Guide to Operating and Maintaining EnergySmart Schools: http://apps1.eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess_o-and-m-guide.pdf

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Anti-Idling Policies for School Buses and Other Vehicles

According to the Environmental Protection Agency (EPA), exposure to diesel exhaust, even at low levels, is a serious health hazard and can cause respiratory problems such as asthma and bronchitis. Diesel emissions are well-documented asthma triggers and may increase the severity of asthma attacks. Asthma is currently the number one cause of missed school days for American children, and asthma affects more than one in nine children in the Northeast. (Source: Asthma Regional Council Web site – see Resources below)

All school systems should adopt a no idling policy that applies to all school buses used to transport the students of the school. The policy should include the following minimum provisions:

- ❑ School bus drivers will shut off bus engines upon reaching destination, and buses will not idle for more than five minutes while waiting for passengers. This rule applies to all bus use, including daily route travel, field trips, and transportation to and from athletic events. School buses will not be restarted until they are ready to depart and there is a clear path to exit the pick-up area.
- ❑ Prohibit idling of all vehicles for more than five minutes (including all passenger vehicles and delivery trucks) in the school zone AND post appropriate signage.
- ❑ School bus companies and drivers will limit idling time during early morning warm-up to manufacturers' recommendations – generally five minutes in all but the coldest weather and for pre-trip safety inspections.
- ❑ Establish provisions for an indoor waiting space for drivers.
- ❑ Evaluate and shorten bus routes whenever possible, particularly for older buses with the least effective emissions control.
- ❑ All bus drivers will receive a copy of the school district's No Idling Policy or equivalent educational materials at the beginning of every school year.

Exceptions are appropriate only to meet state regulations or when running an engine is necessary to operate required safety equipment or perform other functions that require engine-assisted power, e.g., waste-hauling vehicles, handicap accessible vehicles, etc.

Resources

Asthma Regional Council Web site: http://www.asthmaregionalcouncil.org/about/BusToolkit.htm

Sample Policy:
http://www.asthmaregionalcouncil.org/about/documents/SchoolBusNoIdlingPolicy7.29.04.doc

Establishing an Alternative Fueled Vehicle and Equipment Program

Beyond reducing the impact of diesel fueled buses and equipment, school districts may want to consider adopting/promoting clean alternatives to diesel fuel for school bus fleets, and other engine-driven vehicles and equipment. The district should carefully consider the pros and cons of each type of alternative fuel. B-20 bio-diesel is a mixture of 20% agriculturally derived oils and fossil fuel. It burns more cleanly than 100% diesel fuel, although it is known to exhaust elevated levels of nitrogen oxides. B-50 and B-100 (50% and 100% agriculturally derived oils respectively) are also available in many areas. The oil is typically soybean derived and has been successfully used by the United States Military for years. Compressed natural gas (CNG) is an efficient and clean fuel. However, CNG refueling stations can be quite expensive to construct, so this option would be more attractive to communities with existing CNG fuel stations. Diesel hybrid buses employ a mixture of battery power and diesel fuel power. The technology is available for city transit buses and is currently being studied for its applicability to school buses. Early results indicate that "plug-in" hybrid electric-diesel school buses, which charge at night, exhaust few emissions, and can reduce fuel costs over the life cycle of the bus.

Resources

EPA's Clean School Bus USA: http://www.epa.gov/cleanschoolbus/

ICLEI's Clean School Bus Initiative Biodiesel Toolkit:

http://www.icleiusa.org/action-center/learn-from-others/clean-school-bus-initiative-biodiesel-toolkit

Maintaining Bicycle and Walking Access to the Facility

Proper maintenance of walking and bicycle paths and providing proper bicycle storage areas will help to encourage students to get to school under their own power. Paths should be kept clear of dirt, stones, and especially broken glass. Warning signs where paths cross roads should be clearly visible and warning lines should be repainted annually. If the paths are part of a town or regional bike path system, it should be clearly understood what portions of the path are the responsibility of the school personnel to maintain.

A bike rack in a secure enclosed space should be provided and kept free of other objects and debris. Providing storage for bike shoes and helmets will help keep the storage room tidy.

For the overall promotion of safe walking and biking to school, it is recommended that districts participate in the National Safe Routes to Schools Program: http://www.saferoutesinfo.org/

Resources

The *National Center for Safe Routes to School* offers information on walking and biking to school: http://www.saferoutesinfo.org/

International Walk to School provides information on encouraging safe walking and biking to school: http://www.walktoschool-usa.org/

Phasing-out the use of CFC and HCFC-based Refrigerants

CFC and HCFC based refrigerants both contain chlorine, a chemical proven to be a significant contributor to ozone depletion. The production and sale of CFC refrigerant-based equipment was banned in the United States in 1995. However, many CFC based air conditioning systems are still in operation. ~~"V~~irgin" HCFCs can no longer be produced or sold after December 31, 2009, and all HCFC refrigerants are scheduled to be phased out by 2030. Further, the U.S. Environmental Protection Agency is considering accelerating the phase-out of HCFCs.

School systems should install no CFC or HCFC-based refrigerants in building Heating, Ventilating, Air Conditioning, & Refrigeration (HVAC&R) systems when renovating or adding systems to the school. Consider replacing any equipment that utilizes CFC or HCFC-based refrigerants and is over ten years old. It is economically beneficial to install newer, more efficient equipment and take advantage of efficiency program incentives. Implementing a plan to phase-out the use of such refrigerants in all existing equipment within five years will also return efficiency and environmental benefits.

In replacing such equipment no refrigerants should be released into the atmosphere. Licensed and trained contractors should remove the used equipment, complete with all refrigerants, for proper disposal/recycling.

Resources

Greening your Refrigerants; USGBC:
http://www.fmlink.com/ProfResources/Sustainability/Articles/article.cgi?USGBC:200607-25.html

U.S. EPA Refrigerant Guidelines and Regulations:
http://www.epa.gov/Ozone/title6/608/index.html

Utilizing School Facilities as Teaching Tools

A high performance school offers an excellent opportunity to serve as a teaching tool for students, staff, and the public. A plan to utilize school facilities as teaching tools for environmental quality, energy efficiency, and renewable energy should include annual training of all staff in the educational and environmental benefits of the facility and an informational kiosk or other display that presents these same benefits.

A successful plan will include at least the following elements:

- ❑ At least one annual workshop for staff that covers the educational and environmental benefits of the facility
- ❑ A plan to incorporate education regarding the high performance aspects of the school in science and vocational curricula, as appropriate depending on grade level taught
- ❑ An informational kiosk, or other display, in a public area of the school that presents the educational and environmental benefits of the CHPS project

Resources

The Apeiron Institute's Schools Programs offer resources and curriculum for Rhode Island teachers and students: http://www.apeiron.org/new/education/index.php

Cape Light Compact's Energy Education Program provides materials, workshops, and support at no cost to Barnstable and Dukes Counties in Cape Cod: http://www.capelightcompact.org/teachers.html.

The Maine Energy Education Program (MEEP) provides experiential energy education programs for Maine students and teachers: http://www.meepnews.org/.

The National Energy Education Development Project (NEED) is a non-profit organization that works with students, educators, businesses, government, and community leaders to design and deliver energy education programs http://www.need.org. Their catalog of materials may be downloaded at http://www.need.org/needpdf/Catalog.pdf

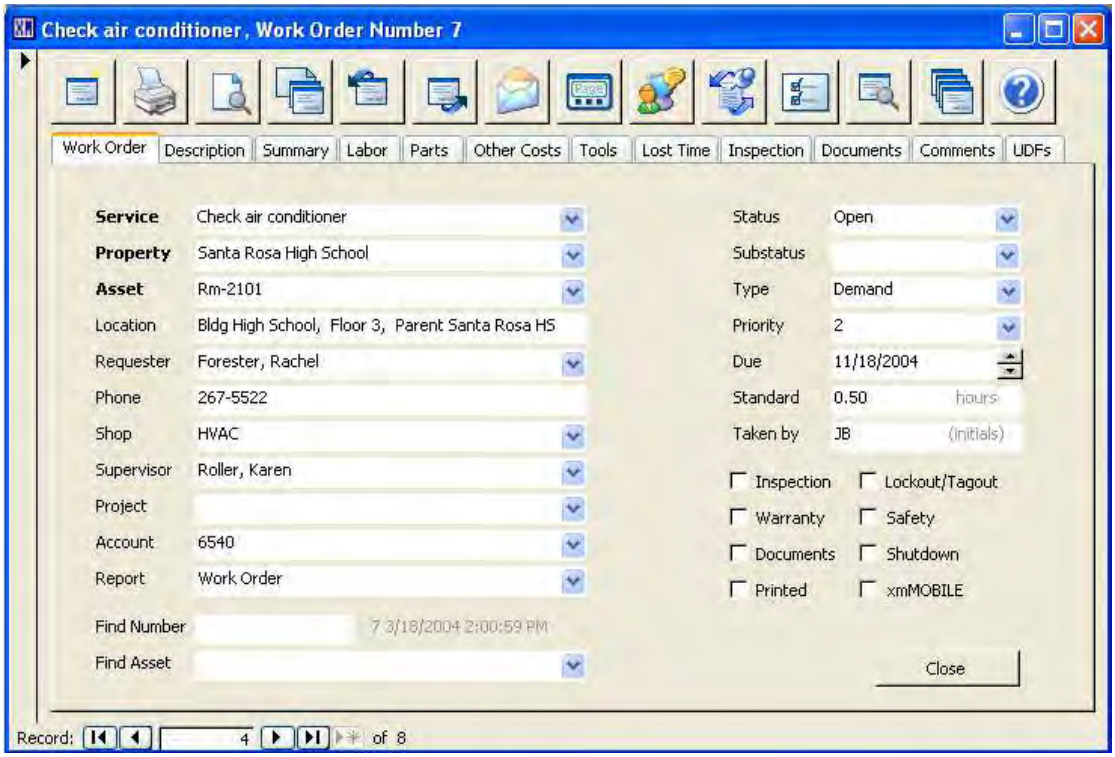
The U.S. Department of Energy offers educational materials for K-12 including lessons plans: http://www1.eere.energy.gov/education.

The Vermont Energy Education Program (VEEP) VEEP provides training and curriculum materials for Vermont teachers on the topics of energy efficiency, renewable energy, and conventional energy sources: http://www.veep.org/.

Utilizing Computerized Maintenance Systems

Computerized maintenance management systems offer the opportunity to enhance maintenance practices through the automatic scheduling and tracking of maintenance procedures. Web-based services and stand-alone products are available. If a computerized maintenance system does not incorporate automated maintenance scheduling, the system can be typically upgraded to allow such capability.

- **SchoolDude™** - An example of computerized maintenance scheduling is the program SchoolDude™ which offers a suite of scheduling programs related to school operations, including:
  - PMDirect™ - An online preventive maintenance scheduling tool that offers over 350 templates for the scheduling of recurring maintenance tasks
  - MaintenanceDirect™ - For online work order management
  - UtilityDirect™ - An online utility tracking and analysis tool
- **MicroMain™ -** Is a software tool that offers automated work orders, preventive maintenance scheduling, vendor/supplier management, etc. A sample screen-shot from the program is presented below:



Resources*

Maintenance World is focused on facility maintenance and maintains a series of articles concerning software tools at this link: http://www.maintenanceworld.com/CMMS-software.htm

SchoolDude's suite of programs: http://www.schooldude.com/

MicroMain™ software: http://www.micromain.com/educationK12.asp

NetFacilities maintenance management software: http://www.netfacilities.com/

CMMS offers several different maintenance management tools: http://www.cmmssoftware.org/

National Institute of Building Sciences: Computerized Maintenance Management Systems: http://www.wbdg.org/om/cmms.php

*These are a sampling of available programs and tools; NEEP does not endorse any specific products.

II. Indoor Environmental Quality

A quality indoor environment is crucial to the health of building occupants and the maintenance of a high level of student and teacher performance. Indoor air quality is the most obvious component of indoor environmental quality, but lighting and views of the outdoors also play a role. Proper indoor environmental quality reduces absenteeism and avoids the potential for long and short-term health problems. Excellent indoor environmental quality is maintained through careful long-term planning and proper maintenance procedures.

Maintaining Access to Views

Access to views has proven to be extremely important in educational and work environments. A human connection to the natural rhythms of the outdoor environment is important to both mental and physical health.

In order to maintain access to views, the facilities staff should consider the following procedures:

- ❑ Make sure that all window blinds and shades are in good operating condition
- ❑ When replacing blinds and shades, select products that allow glare control, not simply black-out shades
- ❑ Avoid displaying school projects on windows
- ❑ Establish a cleaning schedule for glazing and shades
- ❑ Control the growth of vegetation immediately adjacent to vision glazing

Facilitating and Maintaining Daylighting Performance

Students and faculty typically thrive in daylit spaces. But as with access to views, direct sunlight glare restricts the full use of daylighting in most schools. Properly designed daylighting is the best way to illuminate classrooms. Several recent studies have shown that student performance improves dramatically under daylit conditions. However, poorly designed daylighting doesn‘t provide the same benefits, and student performance may actually deteriorate to levels below that of the performance under artificially illuminated spaces. There is also growing evidence that daylighting positively affects circadian rhythms, playing an important role in regulating sleep patterns.

In order to enhance and/or maintain the utilization of daylight, the following should be considered:

- ❑ Replace simple shades and blinds with window shade systems that allow incoming sunlight to be directed to ceiling and wall surfaces to facilitate glare-free daylighting. And, make sure that all window blinds and shades are in good operating condition
- ❑ Utilize blinds and shades to control excess daylighting to avoid glare and overheating of spaces. East and West exposures can be problematic year-round, while South exposures present special problems during the winter months
- ❑ When repainting walls and ceilings select paints with high reflectivity values (85% or higher) to allow these surfaces to be used to bounce indirect sunlight into the space.
- ❑ Avoid displaying school projects on windows
- ❑ Limit the display of school projects on walls that have indirect daylighting potential

- ❑ Establish a cleaning schedule for glazing and shades
- ❑ Control the growth of vegetation immediately adjacent to vision glazing
- ❑ Consider the installation of interior or exterior light shelves to reflect sunlight to ceilings to evenly illuminate the space
- ❑ Conduct a daylighting workshop for teachers and other staff, discussing the advantages and demonstrating proper use of shades and blinds for daylighting performance
- ❑ Install automatic daylighting controls (refer to the Daylighting & Lighting Controls Sections of the Northeast CHPS Protocol for information regarding the installation and commissioning of Automatic Lighting Controls)

Resources

CHPS Best Practices Manual, vol. 2, ~~–~~Daylighting and Fenestration Design" chapter: www.chps.net

Lighting Research Center: http://www.lrc.rpi.edu/researchAreas/daylighting.asp

Pacific Gas and Electric Daylight Initiative: http://www.pge.com/pec/daylight/daylight.shtml

HESCHONG MAHONE GROUP, INC., Daylighting Studies: http://www.h-m-g.com/

Maintaining the Ventilation System with a Goal of Meeting ASHRAE Standard 62.1-2004 for Indoor Air Quality

Modern schools are designed and constructed to meet ASHRAE Standard 62.1 – 2004 for ventilation rates and performance. Achieving good indoor air quality to protect student and staff health and improve performance and attendance is equally important in existing facilities. Supplying fresh air to classroom areas is critical to the protection of good indoor air quality. Facility staff should ensure that the ability of the ventilation system to introduce outdoor air has not been compromised and that Standard 62.1 is met as much as is practicable.

As ventilation systems age, controls drift out of specification and mechanical components fail. A common response to comfort complaints is to block-off or otherwise disable the introduction of outside air. Facility staff should strive to understand how the system is designed to introduce outside air, and provide ongoing maintenance and repair to ensure that outside air is delivered to the student and staff populations.

If outside air has not previously been introduced to the facility, an overall HVAC system assessment will help to ensure that introducing outside air is accomplished cost-effectively and does not adversely affect control strategies and occupant comfort.

Resources

The American Society of Heating, Refrigerating and Air-Conditioning Engineers: http://www.ashrae.org/

Revised Standard 62.1 2007: http://www.ashrae.org/publications/detail/16403

Provide and Maintain Walk-Off Systems

Particles tracked into the school are one of the chief sources of contamination of carpets and floors. Research on school carpeting in particular shows that it can be a reservoir of pesticides, heavy metals, and dust tracked in on students' shoes.

The best way to keep the school free of dust, dirt, and contaminants is to prevent these unwanted items from entering the building in the first place. It is especially important to protect young school children since they are more likely to sit and play on classroom floors and therefore be more exposed to contaminants.

All schools should have a walk-off system at any active entryway. At a minimum, for existing schools, a 15 foot walk-off mat should be provided and frequently cleaned. When renovating, or when otherwise possible, a two or three-part walk-off system that also incorporates grills or grates in addition to a mat will provide enhanced protection.

Walk off system at New Hampshire school

Resources

American School & University article focusing on walk-off mats:
http://asumag.com/mag/university_keeping_clean/

Environmental Design And Construction Magazine: CleanZone Matting System:
http://www.edcmag.com/Articles/Feature_Article/28fa46a3ab697010VgnVCM100000f932a8c0

Cleanlink: http://www.cleanlink.com/sm/article/Matting-Leaving-Dirt-At-The-Door--9209

A Google™ search on the terms "school walk-off mats" generates dozens of suppliers. Specify mats with no PVC or other chemicals.

Reference article on money savings associated with this type of walk-off system:
http://www.mcmorrowreport.com/sfm/articles/mats.asp

National Floor Safety Institute: http://www.nfsi.org/splash.php

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Preventing Irrigation Systems from Spraying Water on Buildings

Irrigation systems that spray water on buildings often cause structural damage and mold growth. Irrigation systems should be redesigned, relocated, and or adjusted to eliminate water spray on buildings.

Replace HVAC Filters on a Schedule

HVAC filters perform an important function, trapping airborne contaminants that would otherwise be re-circulated throughout the facility. But they are often neglected and left in place long after they have become clogged and ineffective. Air circulation is hampered, fan motors work too hard, and containments are often forced around filters and get reintroduced to the indoor environment. A log of filter replacement should be kept and dates should be written on filter frames or on filter doors when replacement is made. If filter doors are not readily accessible, modifying the configuration may be in order. Keeping to the recommended schedule for the filter and equipment type installed will enhance indoor air quality and avoid costly repairs.

Generally speaking, the higher the "Minimum Efficiency Reporting Value" (MERV) rating for filters, the more often they will need to be replaced in order to maintain airflow rates.

Resources

Furnace Filter Care is an independent website with extensive information on filters:
http://www.furnacefiltercare.com

Engineers' Edge article on filter types and performance:
http://www.engineersedge.com/filtration/air_filter_types.htm

Selecting and Upgrading HVAC Filters

The filtering efficiency of HVAC filters is measured on a scale termed the "Minimum Efficiency Reporting Value" (MERV). MERV ratings range from 1 – 16. The higher the MERV value the greater the ability of the filter to extract particulates from the airstream. Some of the common particles related to MERV ratings are dust, spores, bacteria, pollen, insecticide dust, and viruses. Therefore it is clear that indoor air quality can be improved by utilizing filters with higher MERV values.

Common filters found in residential use only have a MERV rating of 1 to 4. Unit ventilators also often have filters that perform in that range, Older unit ventilators (UV) typically utilize filters with a rating of MERV 2, and many have had their filters removed or disabled over the years. Filters found in commercial equipment applications commonly rated at MERV 5 to 8. These filters will collect particles as small as 3 microns.

Filters with a MERV rating of 9 to 12 are used in commercial and industrial applications and will stop particles in the 1 to 3 micron range. The most efficient filters are rated at 13 to 16 and will capture particles as small as .3 microns. These filters are used in hospitals and other super clean environments. When using filters with MERV ratings above 8 it becomes critically important to clean or replace them on the recommended schedule because they will severely constrict air flow when they become clogged with dust, leading to performance problems and decreased operating efficiency.

For most commercial air handling equipment found in schools, MERV 10 filters can be selected without major performance concerns. However, equipment manufacturer specifications and recommendations should be consulted. UVs can typically tolerate filters with MERV ratings no higher than 7.

Resources

Maintenance World Article on selecting filters:
http://www.maintenanceworld.com/Articles/plantengineering/hvac-attack.htm

Furnace Filter Care is an independent website with extensive information on filters:
http://www.furnacefiltercare.com/merv-ratings.php

Engineers' Edge article on filter types and performance:
http://www.engineersedge.com/filtration/air_filter_types.htm

Maintaining Energy Recovery Ventilation Systems

Most schools built in the last several years incorporate energy recovery ventilation (ERV) or heat recovery ventilation (HRV) for at least some of the spaces. For simplicity we will refer to both system types as ERVs in this document. Maintaining proper operation of these units is critical for both indoor air quality and energy efficiency. The two most common types of ERV units are cross-flow plate units with heat exchange cores and units that utilize heat recovery rotating wheels. For any type of ERV system to perform properly, facility personnel must understand how the system functions and the intended control strategy, as well as perform scheduled maintenance.

Commissioning/retro-commissioning of ERV systems – Because they are an integral part of maintaining indoor air quality, ERVs should be properly commissioned (Visit Section VI for more on commissioning) upon installation. If the installed system was never commissioned, or is not functioning properly, retro-commissioning is called for. Commissioning should include calibration of the sensors and controls, measurement and balancing of airflows, training of facility personnel, and the delivery of a complete O&M manual.

Regular Maintenance – Although following the system supplier recommendations for scheduled maintenance is the recommended procedure, depending on system type, some of the maintenance duties may include:

- ❑ Replacing air filters
- ❑ Checking that outdoor air hoods are free of debris and snow/ice
- ❑ Making sure that any condensate drains are clear
- ❑ Check the operation of any frost protection cycle
- ❑ Clean and service the fans
- ❑ Following the manufacturer's recommendations, cleaning of the heat exchange core or wheel
- ❑ Cleaning of ductwork
- ❑ Checking the operation of automatic dampers
- ❑ Checking for the proper operation of system controls (CO_2 sensing, occupancy sensing, timer operation, and parallel control with standard ventilation system are all possible control schemes)
- ❑ Monitoring of CO_2 levels in classrooms and other served areas will help ascertain if the system is delivery adequate outside air

Resources

ACEEE research paper on commercial ERV systems:
http://www.aceee.org/emertech/2009_CommVent.pdf

Sustainable Sources website article on ERVs:
http://energyrecoveryvent.sustainablesources.com/

Contracting Business website ERV maintenance article:
http://contractingbusiness.com/service/cb_imp_6051/

Replacing Pilot Lights with Electric Ignitions

Under certain conditions, the accumulation of carbon monoxide from pilot lights can cause dangerous air quality conditions for staff and students. Therefore, electric ignitions should be specified for all newly installed gas-fired equipment, including water heaters, cooking stoves/ovens, air handling units, and boilers.

Whenever possible, it is advisable to modify any existing gas-fired equipment of the above types with electronic ignitions. Installed equipment that retain pilot lights should be identified and included in scheduled maintenance checks.

Eliminating the Use of Fossil Fuel Powered Maintenance Machinery within the Building

If your school facility still includes mobile equipment inside the building that burn gasoline, propane, or other fossils fuels, now is the time to retire them. Exhaust from equipment such as polishers, burnishers, fork-lifts, etc. pose a serious threat to indoor air quality. Electric powered alternatives are available for all such equipment, and have the added benefit of being significantly more quiet.

Minimizing Mercury Exposure

Fluorescent lamps, high intensity discharge lamps, batteries, and many thermostats contain mercury. It is not possible to completely eliminate mercury from school facilities, but exposure risks can be minimized by eliminating mercury containing thermostats and other equipment, installing only low-mercury lamps, and labeling other products containing significant levels of mercury. In addition, the recycling of all fluorescent lamps and batteries should be included in the school‘s comprehensive recycling program.

According to the United States Environmental Protection Agency, mercury exposure is a serious health and environmental issue that should be addressed in all schools.

From the United States Environmental Protection Agency:

-Health effects of mercury. Mercury exposure at high levels can harm the brain, heart, kidneys, lungs, and immune system of people of all ages. Research shows that most people‘s fish consumption does not cause a health concern. However, it has been demonstrated that high levels of methylmercury in the bloodstream of unborn babies and young children may harm the developing nervous system, making the child less able to think and learn.

Ecological effects of mercury. Birds and mammals that eat fish are more exposed to mercury than other animals in water ecosystems. Similarly, predators that eat fish-eating animals may be highly exposed. At high levels of exposure, methylmercury‘s harmful effects on these animals include death, reduced reproduction, slower growth and development, and abnormal behavior.”

See Section X for more information on mercury recycling.

Resources

United States EPA:

http://www.epa.gov/mercury/about.htm

http://www.epa.gov/waste/hazard/tsd/mercury/con-prod.htm#industry

http://www.epa.gov/epawaste/hazard/wastetypes/universal/lamps/index.htm

http://www.epa.gov/epawaste/hazard/wastetypes/universal/lamps/recycle.htm

Other Resources

http://www.lightingdesignlab.com/articles/mercury_in_fl/mercurycfl.htm

http://www.lamprecycle.org/

III. Integrated Pest Management

Integrated pest management (IPM) includes a set of techniques that are used to exclude pests from buildings and to destroy the habitat of pests by limiting their access to food, water, and free movement without dependence upon chemicals that are harmful to human health. Regular monitoring and record keeping is used to determine when treatments are needed to keep pest numbers low enough to prevent damage. Chemical controls are used only when necessary and in the least toxic formulations that are effective.

As discussed elsewhere in this guide, asthma is one of the most common chronic childhood ailments and is associated with frequent school absences among children. Insect and rodent allergens are known triggers for asthma, and pest infestation affects a range of other human health issues. In addition, pest infestation can be damaging to building structure and systems.

Research demonstrates that the use of insecticides and rodenticides helps to limit infestations, but does not eliminate them. Over time, repeated application of pesticides may lead to resistance among targeted species, requiring greater amounts, or the use of more toxic materials to achieve the same effect.

An IPM program should include, at a minimum, the following measures:

- ❑ For all exterior walls, foundations, attics, roofs, utility chases, and interior partitions and ceilings in food storage, preparation and disposal areas, and penetrations:
  - Block all openings in the enclosure larger than 1/4 inch by 1/4 inch with concrete or mesh-reinforced caulk or copper or stainless mesh or screen over openings that must allow air flow.
  - Caulk all cracks larger than 1/16th inch, including all plumbing and electrical penetrations.
- ❑ Keep all shrubbery a minimum of 3 feet from the building structure.
- ❑ Utilize dumpsters and other rubbish containers that seal tightly and locate them as far away from the building as practicably possible.
- ❑ Do not allow debris to collect near doors and other building openings.
- ❑ Protect building facades so that pigeons cannot roost.
- ❑ Maintain a schedule for the cleaning and degreasing of stoves, refrigerators, cabinets, floors, and walls in kitchens, bathrooms, teacher lounges, etc.
- ❑ Minimize the use of hazardous pesticides.
- ❑ Maintain a schedule and record of treatment.
- ❑ The adoption of the IPM methods detailed in the EPA's *IPM for Schools: A How-to Manual* is recommended. Appendix B of the manual provides a guide for the development of an IPM program. The manual may be downloaded free of charge from the following link: http://www.epa.gov/pesticides/ipm/schoolipm/index.html

Resources

EPA: *IPM for Schools: A How-to Manual:*
http://www.epa.gov/pesticides/ipm/schoolipm/index.html

State and Regional IPM Coordinators:
http://www.epa.gov/pesticides/ipm/ipmcontacts.htm#region1

Safer Schools IPM Guide including several case studies:
http://www.beyondpesticides.org/schools/publications/IPMSuccessStories.pdf

IV. Energy Efficiency

High performance schools incorporate design features and systems that operate with minimal energy usage while providing superior performance. The buildings are well-insulated and resist uncontrolled infiltration/exfiltration. In addition, heating, ventilation, and lighting systems provide premium efficiency and improved comfort levels.

Commissioning, maintenance, and training are critical to the performance of the school and its systems and are key to maintaining energy efficiency. Commissioning involves a rigorous quality assurance program that ensures the building and its systems are built and operated optimally and that the school district receives the proper training and documentation needed to operate and maintain the building. Section VI of this guide specifically addresses commissioning and retro-commissioning. No building can perform optimally without adequate maintenance. Training is critically important for maintenance staff to thoroughly understand how to maintain and operate the building systems, and when staff turnover occurs, documentation must be on hand for the training of new team members.

Understanding and Quantifying Energy Usage

The first step in operating a facility more efficiently is to understand energy usage by recording energy consumption by fuel type, identifying energy using equipment and energy associated building components, and identifying O&M energy efficiency opportunities.

Energy Surveys and Audits

Energy surveys and audits represent the systematic gathering of information that provides a path for determining the energy performance status of a facility at the time of the survey. It further should provide a blueprint for identifying opportunities for energy efficiency improvements. Surveys and audits offer a critical starting point for identifying information about energy usage and the O&M procedures that will reduce operating costs for any facility.

There are several different types of audits that can be useful for identifying energy efficiency opportunities. Setting audit goals and budgets will help in selecting the most suitable type of audit for the facility. The most common types for school facilities are:

Supervised Student Walkthrough Audits – This type of audit is a valuable learning experience for students and can provide insight into building operations, equipment, and the associated energy usage. Metering and logging is not performed, but a comprehensive list of energy related factors can be developed that will prove useful in developing action plans. Some of the issues typically covered are:

- ❑ Building occupancy schedules
- ❑ Energy consumption from utility billing data
- ❑ Survey of plug loads such as computers, copiers, vending machines, etc, and their control strategies
- ❑ Lighting and lighting controls, including the illumination of unoccupied areas
- ❑ Type and age of heating and cooling equipment
- ❑ General condition of building envelope including windows and doors
- ❑ Renewable energy opportunities

Student surveys should always include an action plan that is acted upon by facility personnel and utilized as a starting point for further energy efficiency investigation.

Facilities Personnel Conducted Audits – The next step up are audits that are conducted by the facilities operations staff at the facility. The scope of these audits is only limited by the training and experience of the staff and the amount of staff time available. Training in the conduction of self-audits is often available through efficiency programs. These audits typically include all of the above elements plus:

- ❑ The control strategies, and their operational status for HVAC systems, such as temperature control and setbacks based on time and occupancy
- ❑ An evaluation of the physical condition of HVAC components
- ❑ A review of HVAC maintenance procedures
- ❑ Nameplate information gathering of heating and cooling system model numbers, sizes and rated efficiencies
- ❑ A comprehensive survey of lighting equipment and controls
- ❑ A review of staff resources available for energy system maintenance and oversight

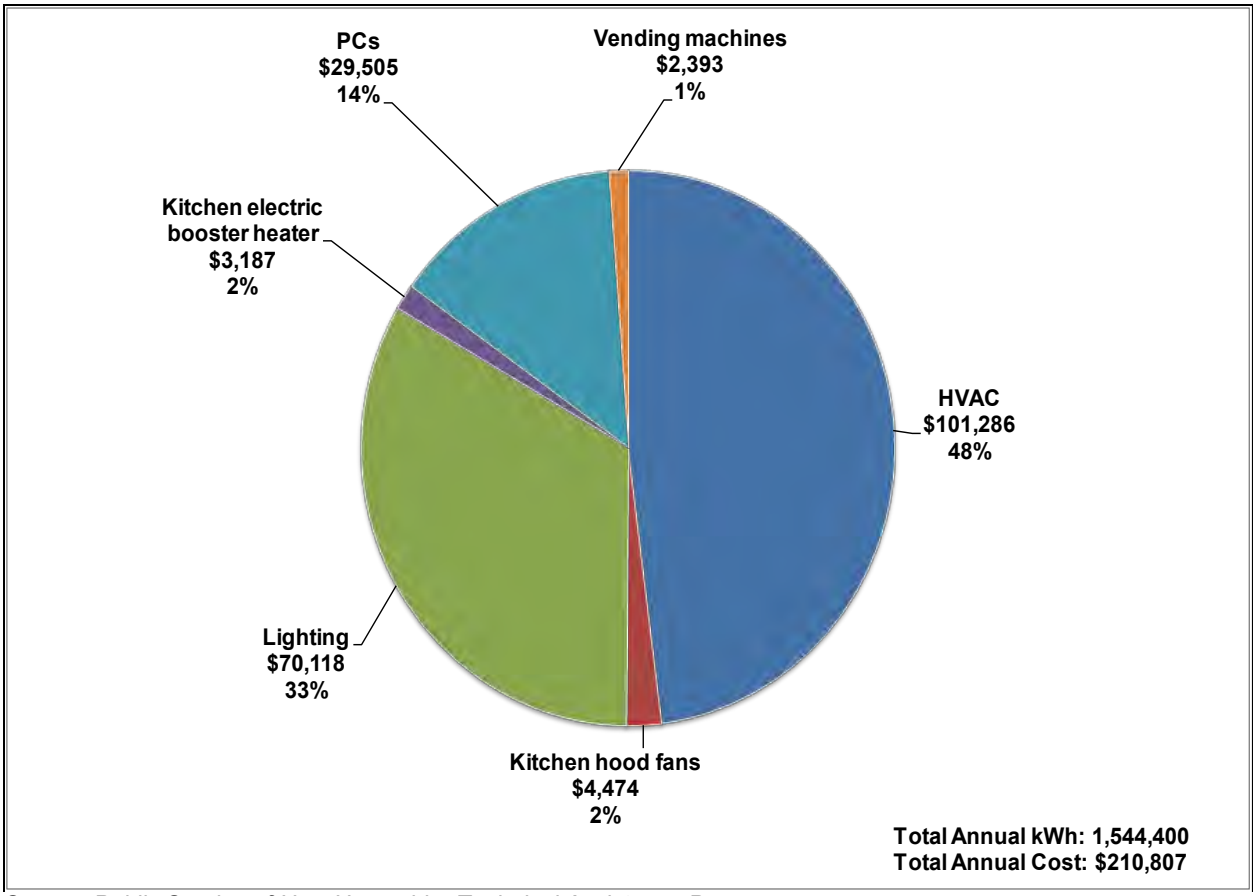
Third-party Comprehensive Audits – The most valuable energy surveys are third-party comprehensive audits. Conducted properly, they provide a comprehensive analysis of the status of the energy performance of the facility as well as specific recommendations for improvement. Third party audits are relatively expensive, but funding is often available through government or utility managed efficiency programs.

The audit analysis should include at a minimum:

- ❑ All of the elements listed in the student and facility personnel audits
- ❑ A full breakdown of energy usage by system type (lighting, heating, air conditioning, plug loads, etc)
- ❑ An analysis of energy usage trends over at least a full year‘s time period
- ❑ Low cost/no cost recommendations for improving the operational efficiency of installed equipment
- ❑ Recommendations for the retrofit and/or replacement of energy using equipment
- ❑ Referrals to appropriate energy efficiency programs for the funding of projects

Figure 1

Energy Usage Breakdown from Actual New Hampshire Middle School Audit



Source: Public Service of New Hampshire Technical Assistance Program

Figure 2
Energy Efficiency Recommendations from the Same NH Audit

No.	Energy Efficiency Measures	Energy Savings (kWh)	Demand Reduction (kW/mo)	Gas Savings (therms/yr)	Total Cost Savings ($/yr)	Installed Cost	Simple Payback (Years)
1	EMS Optimization - Demand contr ventilation	-	-	10,633	$12,015	$7,000 - $8,000	0.6 - 0.7
2	Replace electric booster heater with gas-fired equivalent	30,799	31.5	(1,917)	$3,473	$2,500 - $4,000	0.7 - 1.2
3	Vending miser	8,974	-	-	$908	$1,200 - $1,300	1.3 - 1.4
4	Building envelope improvements	-	-	4,078	$4,608	$6,300 - $6,900	1.4 - 1.5
5	Motor Replacement and VFD Installation	167,440	-	-	$16,938	$27,000 - $30,000	1.6 -1.8
6	Lighting controls	23,865	-	-	$2,414	$5,000 - $6,000	2.1 - 2.5
7	Lighting Retrofit	146,930	45.7	(2,951)	$15,188	$65,000 - $75,000	4.3 - 4.9
8	Install Daylight Controls	800 - 900			$80 - $90	$700 - $800	8.8 - 8.9
9	Kitchen hood control	1,275	-	671	$888	$11,000 - $12,000	12.4 - 13.5
Totals		**379,283**	**77**	**10,514**	**$56,432**	**$125,700 - $144,000**	**2.2 - 2.6**

Source: Public Service of New Hampshire Technical Assistance Program

Benchmarking Facility Energy Usage

Benchmarking is a process by which schools can tabulate and compare their energy use with similar schools around the region, or nation. The information obtained through benchmarking is useful for identifying potential problems and to provide the impetus for school and district administrators to pursue energy upgrades.

As with comprehensive auditing, one of the primary steps is to develop a report of the district's energy usage through current and historical consumption and from utility bills and/or energy management systems. Many utilities will provide online access to account information, easing the administrative burden.

The online benchmarking tool, ENERGY STAR Portfolio Manager, provides a relatively simple method for assessing a school's energy performance and water consumption in relation to other schools. Users input building specific construction and usage information, as well as energy billing information. An energy consumption score ranging from 1 to 100 is calculated for comparing the energy performance with the performance of similar schools. The tool is also useful for benchmarking ongoing performance compared with historical performance for the same facility. A "Benchmarking Starter Kit" is available at; www.energystar.gov/benchmark. When seeking a Portfolio Manager Statement of Energy Performance, discussions with a Registered Professional Engineer should start early in the process to ensure that the process and expectations are understood by all parties. A sample Statement of Energy Performance is illustrated in Figure 3.

Figure 3
Example Portfolio Manager *Statement of Energy Performance*

OMB No.
2060-0347

STATEMENT OF ENERGY PERFORMANCE Office Sample Facility

Building ID: 1678984 **For 12-month Period Ending:** May 31, 2009[1]

Facility	**Facility Owner**
Office Sample Facility	Sample Owner
1234 Main Street	1500 Test Avenue
Charlotte, NC 28227	Charlotte, NC 28227
	555-555-5555

Year Built: 2000
Gross Floor Area (ft2): 53,232

Energy Performance Rating[2] (1-100)
85

Site Energy Use Summary[3]

Electricity - Grid Purchase(kBtu)	2,288,770
Natural Gas (kBtu)[4]	1,162,996
Total Energy (kBtu)	3,451,766

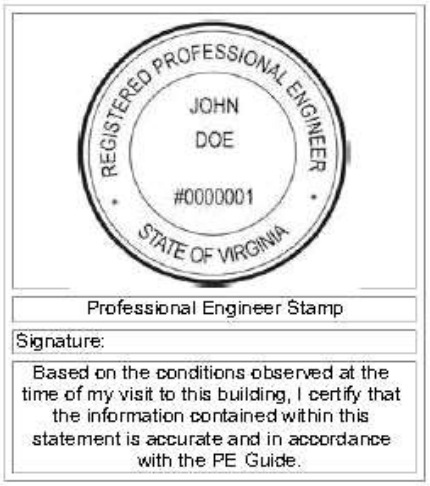
Energy Intensity[5]

Site (kBtu/ft2/yr)	65
Source (kBtu/ft2/yr)	166

Emissions (based on site energy use)

Date SEP becomes ineligible:
September 28, 2009
Date SEP Generated: August 27, 2009

Greenhouse Gas



Professional Engineer Stamp

Signature:

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate and in accordance with the PE Guide.

Emissions ($MtCO_2e$/year) 409 **Electric Distribution Utility** Duke Energy Carolinas, LLC **National Average Comparison** National Average Site EUI 102 National Average Source EUI 261 % Difference from National Average Source EUI -36% Building Type Office

Meets Industry Standards[6] **for Indoor Environmental Conditions:** Ventilation for Acceptable Indoor Air Quality **Yes** Acceptable Thermal Environmental Conditions **Yes** Adequate Illumination **Yes**

Notes:

Primary Contact for this Facility
Jane Smith 1500 Test Avenue Charlotte, NC 28227 555-555-5555
jsmith@jsmith.com

Professional Engineer
License Number: 0000203 State: NC John Doe 33 Country Lane Charlotte, NC 28227 555-555-7788

Resources

ENERGY STAR Portfolio Manager: www.energystar.gov/benchmark

DOE – Energy Smart Schools program:
http://www1.eere.energy.gov/buildings/energysmartschools/

Utility and Government Supported Energy Efficiency Programs:

Cape Light Compact: http://www.capelightcompact.org/

Connecticut Light and Power: http://www.cl-p.com/

Efficiency Maine: http://www.efficiencymaine.com/

Efficiency Vermont: http://www.efficiencyvermont.com/pages/

National Grid. http://www.nationalgridus.com/

NSTAR Electric: http://www.nstaronline.com/business/

NYSERDA: http://www.nyserda.org/

Public Service of New Hampshire: http://www.psnh.com/

United Illuminating: http://www.uinet.com/

Unitil: http://www.unitil.com/

Western Mass Electric: http://www.wmeco.com/

National Association of State Facilities Managers provides information of facility assessment: including energy usage: http://www.nasfa.net/

Implementing a Master Energy Efficiency Plan

Armed with the information garnered from audits and/or benchmarking, it is valuable to develop and implement a master plan for energy efficiency improvements. In developing this plan it is best to set energy usage reduction goals for the facility. Benchmarking the school against other schools can be very useful in setting these goals. In most cases, improving the energy efficiency of existing schools by at least 15% is very reachable without major renovations. Lighting retrofits, HVAC tune-ups and maintenance, installation or the commissioning of existing automatic controls, and the tightening of building envelope often will achieve this level of savings.

Items that should be considered in a Master Plan include:

- ❑ Fenestration performance
- ❑ Lighting controls
- ❑ Light power density (lighting power per ft² of floor space)
- ❑ Mechanical equipment efficiency
- ❑ Domestic water heating efficiency
- ❑ Fundamental economizer performance if air conditioning is installed
- ❑ Management and reduction of plug loads

School systems should work with local and state-wide energy efficiency programs to identify

and address all cost-effective energy efficiency opportunities.

Resources

Core Performance Guide by New Buildings Institute, Inc. 2007 edition: http://www.newbuildings.org.

ANSI/ASHRAE/IESNA Standard 90.1 – *Energy Standard for Buildings Except Low-Rise Residential Buildings*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, GA, 1999, 2001, 2004: http://www.ashrae.org.

ENERGY STAR – a federal-government-sponsored program helping businesses and individuals protect the environment through superior energy efficiency: http://www.energystar.gov/

DOE – Energy Smart Schools program: http://www1.eere.energy.gov/buildings/energysmartschools/

Cape Light Compact: http://www.capelightcompact.org/

Connecticut Light and Power: http://www.cl-p.com/

Efficiency Maine: http://www.efficiencymaine.com/

Efficiency Vermont: http://www.efficiencyvermont.com/pages/

Long Island Power Authority (LIPA): http://www.lipower.org

Massachusetts Clean Energy Center: http://www.masscec.com/

National Grid. http://www.nationalgridus.com/

New Hampshire Electric Co-op: http://www.nhec.com/

NSTAR Electric: http://www.nstaronline.com/business/

NYSERDA: http://www.nyserda.org/

Public Service of New Hampshire: http://www.psnh.com/

United Illuminating: http://www.uinet.com/

Unitil: http://www.unitil.com/

Western Mass Electric: http://www.wmeco.com/

Maintaining the Building Envelope for Energy Efficiency and Occupant Health

Controlling air and water leakage are critical to controlling energy usage in any facility. Even if best practices were followed during construction, continual attention to the building envelope is necessary if energy costs are to be controlled. Inspection and repair of envelope penetrations, roof and wall transitions, and fenestrations should be a part of the regularly scheduled maintenance for schools.

The regularly scheduled maintenance of the building envelope should include:

- ❑ The inspection of exterior walls and roofs for the deterioration of materials and the growth of molds or algae.
- ❑ For masonry construction, mortar should be checked or cracking and re-pointed as needed. Efflorescence, the deposit of salts on exterior masonry surfaces is an indicator of air and vapor leakage through the structure.

- ❑ The removal or trimming of tress or shrubbery growing close to buildings that might contribute to mold and fungus damage, or block access for regular maintenance.
- ❑ The inspection of all windows and doors for signs of failing caulking and weatherstripping. If caulking is cracked, it is often best to remove and recaulk, rather than to attempt a surface patch. Be sure to select caulks formulated for the particular building materials to be sealed.
- ❑ The inspection and sealing/resealing of all envelope penetrations (pipes, vents, ducts, conduit, etc.)
- ❑ The inspection of all transitions from one envelope element to another (foundation to walls, walls to roof, wall assembly to wall assembly, etc). These areas are all prone to air and water leakage and often are never properly sealed at the time of construction.
- ❑ As much as is practicable, the inspection of insulation for signs of water absorption from leakage or from vapor diffusion. Wet insulation has very little insulating value and is a prime candidate for mold growth.
- ❑ The cleaning of all rain gutters and downspouts to ensure that water is transported away from the building.
- ❑ Consider periodically hiring a firm or individual to perform infrared photographic thermal imaging/scanning of the building envelope to identify areas of excessive air leakage, insulation gaps, and wet or deteriorated insulation.
- ❑ For smaller areas that can be isolated, consider hiring a firm to conduct blower door testing to evaluate the air-tightness of the area.

Resources

U.S. Environmental Protection Agency, Tools for Schools, Inspection Guidelines:
http://www.epa.gov/iaq/schools/actionkit.html

The Air Barrier Association of America provides a wealth of information concerning the techniques and materials involved in properly installing air barriers, and air sealing techniques:
http://www.airbarrier.org

National Inspection Services, "Tips for Inspecting and Maintaining a Commercial Property":
http://www.nationalinspection.net/inspector/articles/tips_commercial.html.

For information on blower door testing, visit the following DOE Web site:
http://www.energysavers.gov/your_home/energy_audits/index.cfm/mytopic=11190

Maintaining and Retrofitting Lighting Systems

Quality lighting is crucial for educational environments. Good lighting design and the use of appropriate lighting technologies are important, but proper maintenance is equally important to preserve performance. Proper maintenance will keep lighting systems operating efficiently, keeping lighting levels up and energy costs under control.

Lighting Maintenance

Even the best designed lighting systems will lose significant lighting output if not properly maintained. Lamps and fixture surfaces collect dust rapidly and lenses and painted surfaces are attacked by ultraviolet radiation, losing their abilities to transmit or reflect light. Proper

maintenance will keep lighting levels up to specified levels and forestall lighting replacement and redesign.

A lighting maintenance plan should be developed that includes:

- ❑ The periodic cleaning of lamps, lenses, and fixture surfaces (annually or more often)
- ❑ Visual inspection for faded or flickering lamps
- ❑ The measuring of light levels with a simple foot-candle meter to address low-light level complaints
- ❑ Inspection of manual and automatic controls for proper function and to make sure controls have not been disabled
- ❑ The cataloging and stocking of proper replacement lamps and ballasts
- ❑ The replacement of all incandescent lamps with the appropriate compact fluorescent lamp or a complete linear fluorescent fixture
- ❑ A lamp recycling policy and a proper storage place for lamps awaiting recycling (See Section X for more information on mercury recycling)

Re-lamping Fluorescent Fixtures

Depending on the lamp selected, fluorescent lamps have an average life of 10,000 to 30,000 operating hours. The way lamps are rated, the average life is the number of operating hours at which half of the installed lamps are expected to fail, based on testing of that lamp type. The average life will vary somewhat based on operating temperature and the number of on/off cycles.

Group re-lamping is often promoted as a maintenance cost-savings strategy. Group re-lamping refers to replacing all of the lamps in a room or area at one time whether they have failed or not. It is sometimes recommended by lamp manufacturers that group re-lamping be performed when the first lamps in an area fail. This is a costly mistake, as a small %age of lamps fail long before average life is reached. A much better group re-lamping strategy is to replace all lamps in an area when they have operated for approximately 75% of their rated life. This will mean that operating hours will need to be estimated for space types, and spot re-lamping will need to be performed for early burnouts. Any easier way to obtain similar results is to spot re-lamp until a particular area becomes problematic with lamp failures and then replace all lamps. Date-marking lamps with a Sharpie™ will allow the prevention of replacing a new lamp that was a spot replacement. Cleaning fixtures during re-lamping saves a separate effort.

Spot re-lamping involves replacing individual lamps as they fail. This can often be effectively done as part of a room cleaning routine. A workable approach can be to replace all lamps in a fixture when one of them fails. Badly flickering lamps should be replaced immediately as the flickering is a distraction for students and teachers and usually signals a lamp that is near failure, or a failing ballast.

Fluorescent Ballast Replacement

Note: In many jurisdictions, lighting ballasts may only be replaced by licensed electricians.

Fluorescent lighting ballasts fall under two general categories: electronic and magnetic. Most general use lighting ballasts manufactured today are electronic. But magnetic ballasts represent the vast majority of ballasts installed prior to the 1990s. When magnetic ballasts are near failure, they often become noisy (buzzing sounds) and often cause excessive lamp flicker. Rather than

replace them with ballasts of the same specification, a better approach is to retrofit the fixture with an electronic ballast, or ballasts, and T8 lamps (see the Lighting Retrofit guidance in Section IV).

Older magnetic ballasts may contain PCBs and should be considered hazardous waste. Regardless, all ballasts removed should be disposed of with a certified recycling service. Most services will provide bags and barrels for the storage of ballasts to be recycled.

HID Lighting Maintenance Issues

High intensity discharge (HID) lighting includes metal halide, high-pressure sodium, and mercury vapor lighting. Mercury vapor lighting is now rarely seen, but metal halide is often used for gymnasium lighting, and both metal halide and high-pressure sodium are found in exterior lighting fixtures. Although HID lamps are long lived, they do not maintain their initial light output as well as fluorescent lamps. For this reason, lamps should be observed for significant output reductions and replaced at that time. HID lamps may also start to cycle on and off when nearing end-of-life. HID ballast often become very noisy when near failure and should be replaced when loud buzzing is heard. HID ballasts represent most of the cost of an HID fixture, so ballast failure is a good time to replace the fixture with a more efficient option such as fluorescent high-bays.

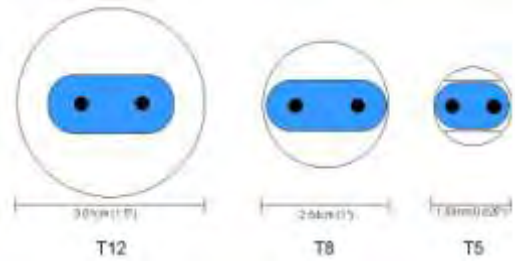
Lighting Retrofits

Classrooms and offices require high-quality electric lighting when daylighting is not available or is insufficient. High-quality electric lighting provides adequate light for the task, improves the rendering of colors, reduces glare, and saves energy. Retrofitting lighting fixtures offers an excellent opportunity to improve facility performance and appearance. With the incentive programs available throughout the region, lighting retrofits pay for themselves very quickly.

Most lighting fixtures installed in schools prior to the 1990s utilize T12 (Tubular 1½" diameter) fluorescent lamps. Modern T8 lamps (Tubular 1" diameter) and their associated electronic ballasts are more efficient, produce higher quality light, maintain their output better (lumen maintenance), and last longer. Nearly all T12 lighting fixtures can be retrofitted with T8 lamps and electronic ballasts. In addition, retrofit kits are available which replace ballasts, lamps, and reflective fixture surfaces as a unit.

Figure 4

T = Tubular, Followed by the Diameter in 1/8" Increments



T8 Lamps & Ballasts – Modern T8 lamps paired with electronic ballasts, provide high-quality lighting combined with excellent energy efficiency. Additionally these systems maintain their light output better over time than do the standard T12 lamps they have replaced. High Performance T8 (HPT8, as defined by CEE, the Consortium for Energy Efficiency) lamp and ballast systems provide enhanced efficiency when compared with other T8 systems. Their cost is only slightly higher than standard T8 systems, and they have become readily available through normal distribution chains. High Performance systems are listed on the Consortium for

Energy Efficiency's (CEE) Web site: http://www.cee1.org./. Most energy efficiency incentive programs throughout the Northeast also use the CEE list for incentive qualification.

T5 Lamps & Ballasts – T5 (5/8" diameter) lamps are also excellent choices for classroom lighting when the fixture is being replaced. They will not fit in standard T12 or T8 fixtures without modification of the fixture. It is often assumed that because T8 lamps are more efficient than T12 lamps, that T5 lamps are more efficient than T8 lamps. This is not accurate, as many T8 lamps produce more light per watt (efficacy) than do T5 lamps. However, the thin profile of T5 lamps makes them ideal for use in fixtures where optical control is important. For this reason, many high performance lighting fixtures incorporate T5 lamps. Because they produce a lot of light for their size, T5 lamps produce a significant amount of glare and should only be used in fixtures that hide the lamp from direct view and optically control glare.

Fixture Types for Lighting Redesigns – Fixture styles that are used to provide high-quality classroom lighting include:

- Pendant mounted indirect or direct-indirect T8 or T5 fixtures – Fixtures should be selected that have a tested overall efficiency of at least 75% and the ceiling should be painted white for good light reflection.
- Recessed or surface mounted indirect or direct-indirect T8 or T5 fixtures – Fixtures should have a tested overall efficiency of at least 65% and shield lamps from direct view.
- Recessed advanced optics T8 or T5 fixtures – This class of fixture is relatively new to the marketplace. Advanced optical features are used to distribute the light evenly and control glare. Tested overall efficiency should be at least 75%. Examples of this fixture style are the Lithonia RT5, Metalux Accord, and LedaLite Pure FX. Retrofit kits that are based on this fixture style have recently reached the marketplace and are a popular option for classroom and office lighting.
- High Intensity Fluorescent T5 and T5 High Output (HO) fixtures – These fixtures are an excellent choice for gymnasiums, field houses, and vocational shop areas. They work best with ceiling heights of 16' or greater. They are often used as 1 for 1 replacements for HID (typically metal halide) fixtures, and offer not only reduced wattage, but also the ability to turn the lights on and off without warm-up times, allowing automatic controls to be put to full use.
- Light Emitting Diode (LED) Solid State Lighting – This is a fast developing technology. LED exit signs have been available for many years and are the perfect choice to replace wasteful incandescent exit signs. White LED lighting for general purpose lighting is now available, but there are remaining questions surrounding long term performance, and the cost is very high. This is certainly a technology to watch and consider for future projects.

Resources

Consortium for Energy Efficiency (CEE): http://www.cee1.org/

Illuminating Engineering Society of North America: http://www.iesna.org/

Advanced Lighting Guidelines, New Buildings Institute: http://www.newbuildings.org/lighting.htm

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Energy Management Systems (EMS)

With the installation of an EMS, proper training of maintenance staff is absolutely critical. The district must be prepared to budget for training both existing staff and new staff hired when

those knowledgeable about the EMS leave employment. Too often system automation is overridden due to failed components, lack of proper documentation, and/or lack of operator training in the system.

The monitoring capabilities of EMS allows for the comparison between various types of building loads throughout all spaces of the school. This information can be used to manage and optimize energy use.

When installing or upgrading an EMS, the system should be capable of the following:

- The monitoring and trending (create trend logs) of controlled variables at the operator interface. Control variables may include air and/or water flow, temperature, pressure, CO_2, and pump or fan speed.
- The trending of outdoor air temperature.
- Monitoring and trending of the status for all equipment with motors greater than 1 hp.
- Indication and trending of damper and valve commanded position.
- Monitoring of building electrical, natural gas, and heating oil demand and consumption.
- Monitoring indoor and outdoor CO_2.
- Data storage – A data storage system with adequate capacity to record trend data for use by building operators. Data export requirements should facilitate user-friendly data access and manipulation.
- Operator interface – An operator interface designed for remote/Web access, monitoring requirements, trend-log reporting, and diagnosing building problems through a user-friendly interface. This includes providing a visual (non-text based) operations and reporting interface to facilitate rapid system assessment that utilizes color coding, diagrams of floor plans, and graphing capabilities.

Reducing or Eliminating Night-time Security Lighting

Several recent studies (see Resources below) have concluded that after hours interior and exterior site lighting do little, if anything, to prevent vandalism. While it is very important to provide security lighting during and immediately following the school day and sanctioned events, significant savings can be realized by reducing or eliminating night time security lighting.

The International Dark-Sky Association's Dark Campus Initiative provides guidelines for establishing a policy that keeps all interior and exterior lighting off after daily activities. They also maintain a list of recommended exterior fixtures for reducing light pollution.

Resources

International Dark-Sky Association: www.darksky.org/

Britain's Royal Commission on the Environment has published a report titled, *Artificial Light in the Environment*: http://www.rcep.org.uk/reports/sr-2009-light/sr-light.htm

The National Institute of Justice Report to Congress: *Preventing Crime: What Works, What Doesn't, What's Promising*: http://www.ncjrs.gov/works/

Maine Legislature Dark Skies Report:
http://docs.darksky.org/Reports/Maine%20Final%20dark%20skies%20report.pdf

HVAC - Maintenance

Boilers

In the Northeastern United States the gas or oil-fired boiler, or multi-boiler system, is typically the largest single piece of energy using equipment in a school building. It is critical to adopt a proper maintenance plan and stick to it. It is also useful to keep detailed records of boiler fuel usage to signal performance deterioration and to assist in troubleshooting. Although sophisticated software is available to analyze energy consumption, simple data analysis, such as comparing energy data with that of similar buildings (benchmarking) can also be useful if it compares buildings with similar equipment and if it is a season to season comparison, normalized for heating degree days.

Maintaining a detailed service notebook should be done in addition to keeping old service invoices. Records that are prepared immediately upon completing maintenance items are most useful for future service calls. Service records and fuel consumption records can show patterns that indicate problems that should be investigated.

Scheduled maintenance should be performed more frequently that once a year, and up to four times per year for older or trouble-prone systems. The maintenance plan should include before and after the heating season start-up/shut-down procedures. Boiler inspection is essential for safe and efficient operation and may already be required by your state. A qualified technician should perform boiler maintenance. However, O&M staff have an important role as well, and should be responsible for:

- ❑ Checking for leaks
- ❑ Looking for damaged or missing insulation
- ❑ Monitoring energy efficiency
- ❑ Checking feedwater
- ❑ Steam trap maintenance in steam systems

Steam Traps

Steam traps are automatic valves that release condensed steam (condensate) from a steam space while preventing the loss of live steam. They also remove non-condensable gases from the steam space. Steam traps are designed to maintain steam energy efficiency for performing specific tasks such as heating a building or maintaining heat for process use. Once steam has transferred heat through a process and becomes hot water, it is removed by the trap from the steam side as condensate and either returned to the boiler via condensate return lines or discharged to the atmosphere, which is a wasteful practice.

Steam Trap Maintenance (Adapted from the Federal Energy Management Program)

Excluding design problems, two of the most common causes of trap failure are oversizing and dirt:

Oversizing causes traps to work too hard. In some cases, this can result in blowing of live steam. As an example, an inverted bucket trap can lose its prime due to an abrupt change in pressure. This will cause the bucket to sink, forcing the valve open.

Dirt is always being created in a steam system. Excessive build-up can cause plugging or prevent a valve from closing. Dirt is generally produced from pipe scale or from over-treating of chemicals in a boiler.

Characteristics of Steam Trap Failure:

Mechanical or Inverted Bucket Steam Traps - These types of steam traps have a "bucket" that rises or falls as steam and/or condensate enters the trap body. When steam is in the body, the bucket rises closing a valve. As condensate enters, the bucket sinks down, opening a valve and allowing the condensate to drain. Inverted bucket traps are ideally suited for water hammer conditions but may be subject to freezing in low temperature climates if not insulated. Usually, when this trap fails, it fails open. Either the bucket loses its prime and sinks or impurities in the system may prevent the valve from closing.

Thermostatic Bimetallic and Bellows Steam Traps - These steam traps have, as the main operating element, a metallic corrugated bellows that is filled with an alcohol mixture with a boiling point lower than that of water. The bellows will contract when in contact with condensate and expand when steam is present. Should a heavy condensate load occur, such as in start-up, the bellows will remain in a contracted state, allowing condensate to flow continuously. As steam builds up, the bellows will close. Therefore, there will be moments when this trap will act as a "continuous flow" type.

At other times, it will act intermittently as it opens and closes to condensate and steam, or it may remain totally closed. These traps adjust automatically to variations of steam pressure but may be damaged in the presence of water hammer. They can fail open should the bellows become damaged or when there are particulates in the valve hole, preventing adequate closing. There can be times when the tray becomes plugged and will fail closed.

Thermodynamic "Disc" Steam Traps - Thermodynamic traps have a disc that rises and falls depending on the variations in pressure between steam and condensate. Steam will tend to keep the disc down or closed. As condensate builds up, it reduces the pressure in the upper chamber and allows the disc to move up for condensate discharge. This trap is a good general type trap where steam pressures remain constant. It can handle superheat and water hammer but is not recommended for process, since it has a tendency to air-bind and does not handle pressure fluctuations well. A thermodynamic trap usually fails open. There are other conditions that may indicate steam wastage, such as "motor boating," in which the disc begins to wear and fluctuates rapidly, allowing steam to leak through.

Thermostatic and Float Steam Traps - Float and thermostatic traps consist of a ball float and a thermostatic bellows element. As condensate flows through the body, the float rises or falls, opening the valve according to the flow rate. The thermostatic element discharges air from the steam lines. They are good in heavy and light loads and on high and low pressure, but are not recommended where water hammer is a possibility. When these traps fail, they usually fail closed. However, the ball float may become damaged and sink down, failing in the open position. The thermostatic element may also fail and cause a "fail open" condition.

Orifice Steam Traps—In the case of fixed orifice traps, there is the possibility that on light loads these traps will pass live steam. There is also a tendency to waterlog under wide load variations. They can become clogged due to particulate buildup in the orifice and at times impurities can cause erosion and damage the orifice size, causing a blow-by of steam.

General Indications of Possible Steam Trap Failure

Abnormally warm boiler room.
Condensate received venting steam.
Condensate pump water seal failing prematurely.
Overheating or underheating in conditioned space.
Boiler operating pressure difficult to maintain.
Vacuum in return lines difficult to maintain.
Water hammer in steam lines.
Steam in condensate return lines.
Higher than normal energy bill.
Inlet and outlet lines to trap nearly the same temperature

The U.S. Department of Energy, Federal Energy Management Program (FEMP) online manual recommends combustion efficiency be measured and recorded at least once a month during the heating season. Combustion efficiency can be measured by a flue gas analysis procedure. Typical combustion efficiency ratings for standard boilers range from 70 to 85 %, with the efficiency ratings for condensing boilers reaching as high as 95 %.

Domestic Hot Water (DHW) - If the facility service hot water is heated by the main boiler(s), consider installing a dedicated DHW system to avoid operating large boilers inefficiently.

Boiler Maintenance/Cleaning Checklist

Description	Comment	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
Boiler use and sequencing	Turn off or sequence unnecessary boilers, and sequence efficient boilers to operate first.	X			
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and that safety systems are in place.	X			
Follow manufacturer's recommended procedures in lubricating all components	Compare temperatures with tests performed after annual cleaning.	X			
Check steam pressure	Is the variation in steam pressure as expected under different loads? Wet steam may be produced if the pressure drops too fast.	X			
Check unstable water level	Unstable levels can be a sign of contaminates in feedwater, overloading of boiler, or equipment malfunction.	X			
Check burner	Check for proper control and cleanliness.	X			
Check motor condition temperatures	Check for proper function.	X			
Check air temperatures in boiler room.	Temperatures should not exceed or drop below design limits.	X			
Boiler blowdown	Verify the bottom, surface and water column blow downs are occurring and are effective.	X			
Boiler logs	Keep daily logs on: • Type and amount of fuel used • Flue gas temperature • Makeup water volume • Steam pressure, temperature, and amount generated • Return water temperature Look for variations as a method of fault detection.	X			
Check oil filter assemblies	Check and clean/replace oil filters and strainers.	X			
Inspect oil heaters	Check to ensure that oil is at the proper temperature prior to burning.	X			

Check flue gas temperatures and composition	Measure flue gas composition and temperatures at selected firing positions — recommended O2% and CO2%. **Fuel O2% CO2%** Natural gas 1.5 10 No. 2 fuel oil 2.0 11.5 No. 6 fuel oil 2.5 12.5 Note: %ages may vary due to fuel composition variations		X		
Check all relief valves	Check for leaks.		X		
Check water level control	Stop feedwater pump and allow control to stop fuel flow to burner. Do not allow water level to drop below recommended level.		X		
Check pilot and burner assemblies	Clean pilot and burner following manufacturer's guidelines. Examine for mineral or corrosion buildup.		X		
Check boiler operating characteristics	Stop fuel flow and observe flame failure. Start boiler and observe characteristics of flame.		X		
Inspect system for water or steam leaks and leakage opportunities	Look for: leaks, defective valves and traps, corroded piping, and condition of insulation.		X		
Inspect all linkages on combustion air dampers and fuel valves	Check for proper setting and tightness.		X		
Inspect boiler for air leaks	Check damper seals.		X		
Check blowdown and water treatment procedures	Determine if blowdown is adequate to prevent solids buildup.			X	
Flue gases	Measure and compare last month's readings for flue gas composition over entire firing range.			X	
Combustion air supply	Check combustion air inlet to boiler room and boiler to make sure openings are adequate and clean.			X	
Check fuel system	Check pressure gauge, pumps, filters and transfer lines. Clean filters as required.			X	
Check belts and packing glands	Check belts for proper tension. Check packing glands for compression leakage.			X	
Check for air leaks	Check for air leaks around access openings and flame scanner assembly.			X	
Check all blower belts	Check for tightness and minimum slippage.			X	
Check all gaskets	Check gaskets for tight sealing. Replace if they do not provide a tight seal.			X	
Inspect boiler insulation	Inspect all boiler insulation and casings for hot spots.			X	
Steam control valves	Calibrate steam control valves as specified by manufacturer.			X	

Pressure reducing or regulating valves	Check for proper operation.			X	
Perform water quality test	Check water quality for proper chemical balance.			X	
Clean waterside surfaces	Follow manufacturer's recommendation on cleaning and preparing waterside surfaces.				X
Clean fireside	Follow manufacturer's recommendation on cleaning and preparing fireside surfaces.				X
Inspect and repair refractories on fireside	Use recommended material and procedures.				X
Relief valve	Remove and recondition or replace relief valves.				X
Feedwater system	Clean and recondition feedwater pumps. Clean condensate receivers and deaeration system.				X
Fuel system	Clean and recondition system pumps, filters, pilot, oil preheaters, oil storage tanks, and other system components.				X
Electrical systems	Clean all electrical terminals. Check electronic controls and replace any defective parts.				X
Hydraulic and pneumatic valves	Check operation and repair as necessary.				X
Flue gases	Make adjustments to ensure optimal flue gas composition. Record composition, firing position, and temperature.				X
Eddy current test	As required, conduct eddy current test to assess tube wall thickness.				X

Source: US DOE Federal Energy Management Program: Boiler Maintenance Checklist (http://www1.eere.energy.gov/femp/operations_maintenance/om_blrchecklist.html)

Furnaces

Few schools in the Northeast heat with warm-air furnaces, but similar procedures apply:

- ❑ Inspect the burners for smooth ignition and proper flame color
- ❑ Check the operation of limit devices or flame sensors
- ❑ Test gas connections for leaks
- ❑ Perform the American Gas Association furnace heat exchanger leakage test annually
- ❑ Inspect the flue for blockage
- ❑ Always see the manufacturer‘s guidelines for proper operation

If staff members identify any problems with the ignition or the flame, facilities personnel or a trained professional should clean the burners as needed and repair or replace the appropriate components.

Unit Ventilators - Best Practices

Herman Nelson invented the unit ventilator (UV) in 1917, and they are still in common use in classrooms today. The first UVs provided heat and ventilation, while many current UVs are also designed to provide air conditioning.

There are many indoor environmental quality issues associated with UVs, including:

- **Fresh Air Delivery** – Theoretically, an advantage of UVs is the delivery of outside air. However, UVs often have design and maintainability issues that cause fresh air delivery to become inconsistent. In addition, staff often blocks off fresh air delivery in older UVs in response to cold air complaints.
- **Short Circuiting of Supply Air and/or Poor Air Distribution** – The short-circuiting of conditioned air between the discharge and the return is a common complaint, made worse when books or other items are placed over the louvers.
- **Classroom Noise** – ANSI Standard S12.60 recommends that classroom equipment noise levels be kept below 35 dB in order to not interfere with student hearing. This level is likely impossible to achieve with UVs. The proper use of acoustical materials such as carpeting, curtains, and acoustical ceilings will help alleviate this problem. Additionally the ability of the unit to operate at lower fan speeds will help reduce noise levels for part of the time.
- **Inefficient Air Filtration** – ASHRAE Standard 52.2 recommends a minimum filtration of MERV 6, and this requirement calls for MERV 7 filtration. Older UVs typically utilize filters with a rating of MERV 2. The added static pressure drop associated with a higher filter rating may significantly affect airflow, especially in older UVs.
- **Difficult Maintenance** – Maintenance of UVs is often neglected, partly because they are difficult to work on. The interior components are crowded into a small case and access usually means lying on the floor.

The following steps should be taken to optimize UV performance:

- All UVs in the facility should be assessed for air delivery, noise, and air filtration.
- All poorly or non-functioning fans, dampers, controls, should be replaced; or the entire UV should be replaced.
- Air filters with a minimum MERV rating of 7 should be installed in each UV. This may require the upgrade of UV fans in some older systems.
- Consider a control strategy that combines occupancy sensing with thermostatic control to avoid bringing excess fresh air into unoccupied areas.
- The facility maintenance plan should include annual maintenance of the UVs.

Bio Alternatives to No. 2 Fuel Oil

Bio-fuels and woody biomass can both be attractive alternatives to standard fossil fuels. Many school systems across the country are beginning to incorporate bio systems for some or all of their heating. In the Northeast, the abundance of waste-wood from the forest products industry has made wood fired systems particularly attractive.

Bio-fuels are technically and economically viable alternatives to No. 2 fuel oil and are less hazardous than petroleum fuels. The addition of bio-fuel combustion capability is simple and inexpensive, as it is not necessary to replace or compromise the operation of existing fossil fuel systems, provided normal material compatibility recommendations for the particular fuel blend are followed.

Just as there are now alternatives to diesel fuel for vehicles, bio alternatives to fuel oil are now reaching the marketplace. A product now available in Massachusetts that will be expanding throughout the region is a blend of standard No. 2 heating oil and biodiesel, which is oil refined from vegetable oil, recycled cooking grease, or animals fats. The currently available blend is

20% biodiesel blended with 80% heating oil. The goal is to increase the biodiesel content as new blended products are introduced.

In order to ensure the quality of the blended fuel, the American Society of Testing and Materials (ASTM) has approved specifications for the biodiesel (D-6751) utilized in formulating the blended product. This standard ensures that the product will be constant and not subject to any harmful contaminants that might come from a non-industrial production method. Most of the biodiesel made today in the United States comes from soy oil. Soy oil is a commodity product extracted in the soy processing system.

Biodiesel Case Study – University of Georgia

As a portion of ongoing research into bio-fuel alternatives, The University of Georgia (UGA) Engineering Outreach Service (EOS) used fats and grease (chicken fat, yellow grease, choice white grease, and beef tallow) as industrial boiler fuels in the 100,000 lb./hr. No. 2 boiler at the UGA steam plant in 2002-2003.

A summary of the results include:

- Laboratory analyses showed that the fats and greases tested have high heating value, low ash, negligible sulfur, low moisture, and other physical and chemical properties conducive to their use as boiler fuel. Heating values for the biofuel blends tested are within 95% of the heating value of No. 2 fuel oil.
- The tests demonstrated that the biofuels burn cleanly, readily, without odor and without damage to boiler equipment.
- During this test program, biofuels produced steam within 3.8% to 5.3% of the efficiency of No. 2 fuel oil. Biofuels blended with No. 2 fuel oil were more efficient than unblended biofuels, and can actually produce steam with more efficiency than No. 2 fuel oil alone. Throughout the tests part load efficiency was greater than maximum load efficiency, and steam production with flue gas recirculation (FGR) was more efficient than without FGR.
- Biofuels are clean burning. They produce fewer combustion emissions than No. 2 fuel oil.
- FGR is an effective way to reduce nitrogen oxide (NOx) emissions for both fossil and biofuels.

Participating in Utility and Governmental Energy Efficiency Incentive and Technical Assistance Programs

Virtually every utility customer in the Northeast region is eligible to participate in at least one, and typically several, energy efficiency programs. The programs offer either technical assistance or incentives for efficient equipment and practices. Many programs offer both technical assistance and financial incentives for the installation of efficient equipment and the incorporation of efficient design practices.

In addition to utility and state government operated programs, the Federal Government offers a tax credit program that will allow the designers of energy efficient buildings to apply for a tax credit to help offset the costs of the design and construction of efficient buildings.

Participation in these programs not only leads to possible financial incentives, but often provides valuable information regarding best practices in the local area and local expert design and consultation services. School administrators should contact their electric and gas utility companies as well as their state energy office for specific program information.

Resources

Cape Light Compact: http://www.capelightcompact.org/
Connecticut Light and Power: http://www.cl-p.com/
Efficiency Maine: http://www.efficiencymaine.com/
Efficiency Vermont: http://www.efficiencyvermont.com/pages/
National Grid: http://www.nationalgridus.com/
New Hampshire Electric Co-Op: http://www.nhec.com/
NSTAR Electric: http://www.nstaronline.com/business/
NYSERDA: http://www.nyserda.org/
Public Service of New Hampshire: http://www.psnh.com/
United Illuminating: http://www.uinet.com/
Unitil: http://www.unitil.com/
Western Mass Electric: http://www.wmeco.com/

V. Alternative and Renewable Energy Systems

Biomass Systems – Woody Biomass (Wood Pellet and Chip) Boilers

Wood-fired boiler systems have become readily accepted for the heating of school facilities. Over 30 schools in Vermont alone are presently heated by wood chip boiler systems.

Wood pellet and chip boilers are relatively simple biomass heating systems. Wood pellets and chips are generally uniform in size, shape, moisture and energy content, so fuel handling is not burdensome. Nevertheless, there are some ongoing maintenance requirements for these systems.

A wood fired boiler will take more time to maintain and operate than a traditional gas, oil, or electric heating system. At the institutional or commercial scale, however, many of the maintenance activities can be cost-effectively automated by installing off-the-shelf equipment such as soot blowers or automatic ash removal systems.

The manufacturer of the installed system should supply a schedule for required maintenance. When considered on a daily basis, the total time required for maintaining wood fired boiler systems equates to roughly 15-30 minutes per day over the entire heating season. Some of the typical maintenance activities required for wood fired boilers include:

- ❑ Ash removal from grates and/or collection containers
- ❑ Monitoring control devices to check combustion temperature, stack temperature, fuel consumption, and boiler operation
- ❑ Checking and adjustment of fuel feed rates and combustion air
- ❑ Checking boiler settings and alarms, such as those that alert to a problem with soot buildup
- ❑ Boiler tube cleaning
- ❑ Cleaning of firebox and heat exchange surfaces
- ❑ Greasing augers, gear boxes, and other moving parts
- ❑ Checking for wear on conveyors, augers, motors, or gear boxes

Resources

ASHRAE standard 55: http://www.ashrae.org

US DOE: "Guide To Operating and Maintaining Energy Smart Schools": www.eere.energy.gov/buildings/energysmartschools/

FEMP boiler maintenance recommendations: http://www1.eere.energy.gov/femp/operations_maintenance/om_boilers.html

FEMP steam trap information: http://www1.eere.energy.gov/femp/operations_maintenance/om_stmaintenance.html

New England Fuel Institute: http://www.nefi.com/

National Biodiesel Board: http://www.biodiesel.org/

The Massachusetts Biodiesel Heating Fuel Program:
http://massenergy.com/MECA_BIOIL/index.htm

University of Georgia Engineering Outreach Service: ~~–~~A Demonstration of Fat and Grease as Industrial Boiler Fuel":
http://outreach.engineering.uga.edu/services/Final%20Biofuel%20Oil%20Report%20-%20Executive%20Summary.pdf

The Biomass Energy Resource Center (BERC) in Montpelier, Vermont is an independent, national nonprofit organization that offers information and assistance regarding biomass systems: http://www.biomasscenter.org/

Wood Chip Heating Systems and *Vermont Fuels for Schools* are both useful guides to wood-fired systems and are downloadable at this address:
http://www.biomasscenter.org/resources/publications.html

Massachusetts Division of Energy Resources: *Wood Pellet Heating: A Reference on Wood Pellet Fuels & Technology for Small Commercial & Institutional Systems:*
http://www.mass.gov/Eoeea/docs/doer/publications/doer_pellet_guidebook.pdf

Manual boiler tube cleaning at Calais Elementary School, Calais, Vermont (from the Biomass Energy Resource Center's Wood Chip Heating Systems)

Maintaining Solar Thermal and Photovoltaic (PV) Systems

As with all energy producing equipment, proper maintenance of site-installed solar systems is essential to long-term performance and the avoidance of costly repairs. The tasks involved are not onerous, but are often not well communicated to facility personnel and/or neglected in favor of tending to other immediate needs (putting out fires).

Solar panels at Providence Career and Technical Academy in Providence, RI

O&M Manual - All solar system installations at school facilities should include an O&M manual that describes exactly how the system works and the recommended scheduled maintenance to be performed by both the owner and the contractor. The O&M manual should not

be merely a compilation of component manufacturers' literature, but should include instructions specific to the installed system.

Solar Thermal Systems

Solar thermal systems for service water heating and supplemental space heating are making a strong comeback in the United States. During the late 1970s and early 1980s, thousands of solar thermal systems were installed on residences, schools, and businesses with the support of federal and state incentive programs. Much was learned about the maintenance of solar systems, and that knowledge should be applied today to ensure that investments in solar technology contribute to reduced energy consumption for the next decades.

Monitoring Performance – Nearly all systems are installed with at least some temperature probes, and many include flow meters and digital temperature monitoring at several points in the system. Monitoring and recording system performance over time will assist in identifying problems early. Some operators keep daily logs, but weekly recorded information is sufficient. At a minimum, a log should be kept of the following:

- ❑ Time of day and weather conditions at time of reading
- ❑ Temperature at the collectors
- ❑ Temperature of fluid entering the heat exchanger or storage tank
- ❑ Temperature of fluid exiting the heat exchanger or storage tank
- ❑ Temperatures at the bottom and top of the storage tank
- ❑ Transfer fluid flow rate (if a flow meter is installed)
- ❑ Transfer fluid pressure (closed loop systems only)

If degraded performance is observed, a troubleshooting exercise should be performed by staff with the assistance of the solar contractor. Likely component failures include:

- ❑ Leaking transfer fluid
- ❑ Shorted or out of specification thermisters (temperature sensors)
- ❑ Faulty differential thermostat control
- ❑ Failed circulator pump
- ❑ Inoperable automatic valves such as check valves, vacuum relief valves, mixing valves
- ❑ Failed expansion tank
- ❑ Other

Regular Maintenance – Some of the following maintenance items would typically be performed by the installing, or other, solar contractor. A thorough visual inspection of the system should be done every six months looking for any signs of corrosion of mounting hardware, exposed control wiring, leaking roof penetrations, broken glazing seals, plumbing leaks, loose pipe insulation, etc. The collector glazing rarely will need cleaning unless there is a nearby pollution source. If needed, the glass should be cleaned with plain water only.

For closed loop systems utilizing propylene-glycol as a heat transfer fluid, maintaining the fluid is extremely important. Although solar system rated glycol solutions contain corrosion inhibitors, if the fluid becomes acidic it will start to corrode the inside of the plumbing loop. Glyco solutions breakdown with extended overheating, which can occur if circulation stops during sunny weather causing the fluid in the collectors to overheat. The fluid should be tested once a year for

pH and some technicians also test for reserve alkalinity. Use only propylene glycol with corrosion inhibitors rated for solar thermal systems when adding or replacing glycol.

Pressurized water storage vessels should be maintained as any pressurized water heater.

Solar Photovoltaic (PV) Systems

PV systems require less routine maintenance than do solar thermal systems. However, simple maintenance procedures will protect the investment and keep the system operating at peak output. As with solar thermal, monitoring of system performance will signal most significant issues.

Note: The information presented here assumes that the PV system is grid connected and not a stand alone system with storage batteries. If the system includes storage batteries, it is extremely important that facility personnel follow the manufacturer's safety and maintenance recommendations.

Monitoring System Performance – Any PV system installed on a school should include a meter that records the amount of energy generated and/or the energy being exported to the grid. If the metered information is downloadable to a computer, the performance of the system can easily be tracked over time. If the meter simply displays the output, a log should be kept that includes time of day, date, weather conditions, and system output in order to record performance over time.

PV system owners should not expect the system to operate at the full rated output. The energy industry uses the term "Performance Ratio" to identify the actual system output. According to the National Renewable Energy Laboratory (NREL), the standard performance ratio for a new PV system averages 77%, and over time the performance of the system is expected to degrade at the rate of about 1% per year.

Periodic System Inspection – The system should receive a thorough visual inspection on a schedule, as recommended by the manufacturer or installation company. The following items should be included:

- ❑ Safety first – PV systems are electrical systems with all the dangers inherent in any electrical devices.
- ❑ Inspect the modules for any cracks or discoloration.
- ❑ Inspect module mounting hardware for any signs of corrosion or other damage.
- ❑ Check that the inverter is being kept clean and dry and that the proper indicator lights are on.
- ❑ Check circuit breakers.
- ❑ Look for any loose electrical connections and any deterioration of the weatherproofing of electrical components.

Regular Maintenance – As with solar thermal panels, the glass surface rarely needs cleaning as rain does a pretty good job of this. If there is a need to remove a layer of dust and dirt from the modules, simply wash them with plain water.

Resources

The Northeast Sustainable Energy Association (NESEA) maintains a searchable library of solar and other renewable energy resources: http://www.nesea.org/

Solar Energy Industries Association: http://www.seia.org/

The Florida Solar Energy Center has been active in solar energy research since the mid 1970s: http://www.fsec.ucf.edu

Solar Industry Magazine publishes many online articles concerning the maintenance of solar systems: http://www.solarindustrymag.com

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Site Installed Wind Systems

Wind machines are electro-mechanical devices that require the same attention to maintenance as any such device. The following excerpt is from the American Wind Association article, *Wind System Operation and Maintenance Costs*:

—. . things do wear out, or just plain wear. Alternator bearings cannot be expected to spin for years without replacement. The same holds true for yaw bearings with their significant loading. Dust, debris, and even insects in the wind will eventually erode the most durable blade materials, leading edge tapes, and paint coatings. Tail bushings and governor components, subjected to dirt and moisture, inevitably wear as the turbine governs in storms or during windy periods. Paint coatings, subjected to sunlight, moisture, and temperature extremes will eventually deteriorate. If your system has a gearbox, the lubricant will degrade over time, just as the oil in your car engine does. So, don't assume that your wind turbine will spin for 20 years carefree. While today's turbines are vastly improved over past offerings, you will need to allocate some money for repairs."

Wind system owners should work with their system manufacturer and installer to develop a regular maintenance plan. As with solar systems, the recording of performance over time will supply much valuable information.

Resources

American Wind Energy Association: http://www.awea.org/

The Northeast Sustainable Energy Association (NESEC) maintains a searchable library of renewable energy resources: http://www.nesea.org/

World Wind Energy Association: http://www.wwindea.org

VI. Commissioning and Retro-commissioning

Commissioning and retro-commissioning are procedures that verify that fundamental building elements and systems are designed, installed, and calibrated to operate as intended and provide for the ongoing accountability and optimization of building energy performance over time. High performance buildings are healthy, efficient, environmentally sensitive structures whose performance can be significantly affected if the building cannot be operated according to the designers' specifications. Commissioning is a rigorous quality assurance program that seeks to ensure that the building performs as expected.

Commissioning Existing Buildings and Systems

Retro-commissioning is essentially the commissioning process applied to equipment and/or systems that were never commissioned properly after being installed, or are no longer operating to specification. This later form of retro-commissioning is sometimes referred to as re-commissioning.

The following retro-commissioning procedures are recommended:

1. **Engage a commissioning agent** - The commissioning agent (CA) directs the commissioning process and should be performed by an independent third party
2. **Develop a retro-commissioning plan** - The retro-commissioning plan includes a list of all equipment and systems to be retro-commissioned, delineation of roles for each of the primary retro-commissioning participants, and details on the scope, timeline, and deliverables throughout the retro-commissioning process. Examples of equipment to consider for retro-commissioning include:
   - ❑ Lighting Controls
   - ❑ HVAC Controls
   - ❑ Energy Management Systems
3. **Perform verification** - Verify installation, functional performance, training, and operations and maintenance documentation for each retro-commissioned system and feature. This is the heart of the retro-commissioning process.
4. **Complete a retro-commissioning report** - The report should show that the building's systems have met the design intent and specifications, have been properly installed, are performing as expected, and that proper O&M documentation and training have been provided. The report should include a compilation of all commissioning documentation, including complete functional testing results and forms and should note any items that have not been resolved.
5. **Develop a system operational manual** – This manual should cover the operations and maintenance of all commissioned systems, and the facility staff should be trained in the use of the manual.

Retro-commissioning, maintenance, and training are critical to the performance of the school and its systems and are key to maintaining energy efficiency. Retro-commissioning involves a rigorous quality assurance program that ensures the building and its systems are built and operated as designed and that the school district receives the proper training and documentation needed to operate and maintain the building. No building can perform optimally without adequate maintenance. Training is critically important for maintenance staff to

thoroughly understand how to maintain and operate the building systems. When staff turnover occurs, appropriate documentation must be on hand in order to train new team members.

Commissioning Newly Installed Systems

The commissioning of systems that are newly installed in existing facilities varies only somewhat from the retro-commissioning procedures listed above. It will be important to work closely with the installation contractors to be certain of the various activities that will be performed by the installers, facility staff, and the commissioning agent.

The following commissioning procedures are recommended:

1. **Engage a commissioning agent** – The commissioning agent (CA) directs the commissioning process and should be engaged as early in the design process as possible. If complex systems are involved, the commissioning services should be performed by an independent third party, or performed under separate contract with a member of the design team.
2. **Develop design intent and basis of design documentation** - The design engineer or contractor should work with the facility personnel to create a document that lists the owner‘s requirements and design intent for each of the systems or features to be commissioned.
3. **Include commissioning requirements in the contract documents** - All commissioning requirements should be integrated into the project contracts to clearly specify the responsibilities and tasks to be performed. Of particular importance are the delineation of the contractors‘ responsibilities regarding documentation, functional performance testing, occupant and operator training, and the creation of the O&M manuals.
4. **Develop a commissioning plan** - The commissioning plan includes a list of all equipment and systems to be commissioned, delineation of roles for each of the primary commissioning participants, and details on the scope, timeline, and deliverables throughout the commissioning process.
5. **Perform verification** - Verify installation, functional performance, training, and O&M documentation for each commissioned system and feature.
6. **Complete a commissioning report** - The report should demonstrate that the installed systems have met the design intent and specifications, have been properly installed, are performing as expected, and that proper O&M documentation and training have been provided.
7. **Develop a system operational manual** – This manual should cover the operations and maintenance of all commissioned systems, and the facility staff should be trained in the use of the manual.

For more information and details on how to develop and implement a retro-commissioning plan, please see ―A Retrocommissioning Guide for Building Owners,” compiled by the EPA and Portland Energy Conservation, Inc: www.peci.org/Library/EPAguide.pdf.

Training Building Operators in the Operations and Maintenance of Commissioned Systems

Providing effective and complete training and documentation on the operation and maintenance of building systems is an integral part of the effort. Training programs for school maintenance staff, administrators, teachers, and other staff must be developed and completed. Training is an essential step to protect indoor air quality and maintain superior energy performance.

The following guidelines help ensure that the intended operational procedures of the energy using systems are well-documented and provided to the appropriate facility staff. Additionally, the training of facility staff will ensure that the critical importance of proper operations and maintenance is understood and that design goals are met. These requirements are often included in the contract with third-party building commissioning agents.

1. **Compile operations & maintenance manual** - Provide maintenance and facility staff with detailed operations and maintenance information for all equipment and products in use in the school.
2. **Create a short, classroom "user's guide"** - Provide an explanation for teachers and administrative staff on how to operate their room lighting and HVAC systems.
3. **Conduct operations & maintenance training** - Provide a short introduction for all school staff and then feature a special hands-on workshop for facility and maintenance personnel. Training should include the interaction of the equipment operating together as a system.
4. **Ensure that maintenance and record keeping on building occupancy should include**:
   - ❑ Annual inspections of the HVAC system. Problems found during these inspections should be corrected within a reasonable time. Air conditioning systems should be inspected twice each year – before the cooling season and again after the cooling season.
   - ❑ Inspections and maintenance of the HVAC system documented in writing. The facilities manager (or individual responsible for oversight of facilities maintenance and operation) shall record the name of the individual(s) inspecting and/or maintaining the system, the date of the inspection and/or maintenance, and the specific findings and actions taken. The facilities manager should ensure that such records are retained for at least five years.
   - ❑ Calibrations of all sensors that are part of the HVAC system on a routine basis including CO_2 sensors for CO_2 demand controlled ventilation. Sensors should be calibrated by experts such as controls contractors.

Resources

Building Commissioning Association Certification Program:
http://www.bcxa.org/certification/index.htm

ASHRAE Commissioning Process Management Professional (CPMP) program*:*
http://www.ashrae.org/certification/page/2086

CHPS Best Practices Manual, vol. 2, Guideline GC5: Contractor's Commissioning Responsibilities: http://www.chps.net/

ASHRAE Guideline 1-1996: *The HVAC Commissioning Process* and ASHRAE Guideline 4-1993: *Preparation of Operations & Maintenance Documentation for Building Systems:*
http://www.ashrae.org.

VII. School Bus Maintenance

Aggressive preventative maintenance practices can ensure that a school bus not only responds well in variable conditions but also performs efficiently – thus reducing emissions, cost and health risks. The following are some recommended strategies for improved school bus maintenance.

Meet minimum compliance with manufacturer recommended maintenance. Visually ~~"i~~nspect" bus at least every 41 working days or 15,000 miles.

- ❑ Cracked water hoses, frayed belts, leaking water pump or radiator – while not directly associated with emissions – can contribute to poor performance or reduce efficiency, effectively undermining the buses ability to ~~"r~~un clean."

Visually, audibly and physically inspect the exhaust system. Checking the exhaust system for sounds of holes or fractures should complement an inspection for visible exhaust. Exhaust systems that are not intact can result in fumes entering the cabin and increased exposure for bus riders.

- ❑ Special care should be taken to ensure that exhaust systems are fully intact and secure, and that engine compartments are completely sealed from interior passage space. Place a piece of cardboard or firm paper against the muffler as a means of forcing exhaust through any existing holes in other parts of the exhaust system. This test can identify existing fractures within the system. Drivers should be aware of and check for the visible indicators of smoke and color.

Inspect windows, doors and gaskets for "leaks." Rubber sealants, windows and weather stripping can wear over time and produce holes through which emissions can enter the interior of the bus.

- ❑ Every emergency window or door, as well as the driver's windshield and main cabin door can be ~~"k~~icked-out" in case of emergencies and are sealed by rubber or a similar substitute. As the rubber or other sealants deteriorate over time, exhaust can enter the bus. Checking the weather-stripping around the rear emergency door (or whatever exit is closest to the muffler) to prevent exhaust fumes from entering the bus is critical. Replace broken or cracked window glass and check to see that all windows close securely. A school bus may have as many as 12 (depending upon bus size) emergency exit points (windows and doors) that are sealed by rubber gaskets.

Check and change air filters annually. Visible smoke is generally an indication that fuel remains unburned and, therefore, an engine is not performing at its optimal level.

- ❑ Frequent air filter changes can provide better fuel combustion and can decrease unhealthy soot output by as much as 70 %.[1] Poor combustion not only wastes fuel and creates smoke, but it coats the cylinder walls with fuel that washes protective oil from sealant rings creating more wear. Left unchecked, this can lead to total engine replacement (cost can be $6,000 or greater). Air filters generally cost between $5 and $25.

Change oil every 3,000 miles or 3 months.

[1] Iowa Department of Natural Resources, Air Quality Division

- Synthetic oils can be used to help reduce the possibility of gelling. While the initial costs are higher, it can be a cost effective choice because they don't break down and don't oxidize. Synthetic oils withstand colder temperatures as a result of lower pour points. If synthetic oils are not used, the bus should run on the highest grade petroleum oil.

Maintain Proper Tire Pressure.

- You can improve your gas mileage by around 3.3 % by keeping your tires inflated to the proper pressure. Under-inflated tires can lower gas mileage by 0.3 % for every 1 psi drop in pressure of all four tires. Properly inflated tires are also safer and last longer.

Use blended fuels or fuels that will not gel. Gelling of diesel fuel makes it difficult for the engine to start and to run cleanly or efficiently.

- In cold weather, diesel fuel can thicken or gel to the point that it will not flow through the fuel system. Reduced cranking speed at cold temperatures may produce insufficient heat during compression to ignite the air/fuel mixture. Winter blends (diesel and kerosene) are used to withstand colder temperatures. Fuel additives will reduce gelling and clean the fuel injectors at the same time. Cleaner fuel injectors help the engine run cleaner as well.

Service EGR (exhaust gas recirculation) valve regularly. This helps reduced potential nitrogen oxide (NOx) emissions.

- During certain conditions of engine operation, measured amounts of cooled exhaust gas are routed to the intake manifold. The cooled exhaust gas mixes with the incoming fresh air and displaces some of the oxygen. With less oxygen in the air, the peak temperatures created in the combustion chamber are reduced, and the levels of NOx are also reduced. The lower the temperature, the lower the production of NOx.

Resources

Asthma Regional Council of New England – Clean Buses Initiative:
http://asthmaregionalcouncil.org/indoor-and-ambient-air-quality

US-DOE Fuel Economy Information: http://www.fueleconomy.gov/

School Bus Fleet Website: http://www.schoolbusfleet.com/Channel/Bus-Maintenance.aspx

VIII. Water Efficiency

Outdoor Water Systems

Eliminate Irrigation for Non-Playing Field Landscaping

Significant amounts of potable water are currently used to irrigate landscaping and playing fields. Although the Northeast region receives an average of several inches of rainfall per month, expanding development increases the demand for potable water. As more and more water is withdrawn, aquifers and rivers can be stressed to the point of creating water shortages and ecological changes to rivers and streams. Summer dry spells cause the most stress to underground and surface waters as water is withdrawn for irrigation and other outdoor activities but is not replaced by rainfall.

The use of potable water for irrigation can be minimized or eliminated by specifying drought tolerant plants and grasses, collecting and using rainwater for irrigation, and/or using highly water-efficient irrigation systems. When specifying water conservative plants, determine soil composition and ensure that existing soils will support the plants to be specified. Consider all operating and maintenance costs of any irrigation equipment specified. If irrigation is necessary, make arrangements to irrigate during morning hours to maximize irrigation benefits and minimize evaporation.

The best types of soil for playing fields are 3% to 7% organic content and fall into the following U.S. Department of Agriculture soil categories:

Soil Type	Watering Requirements
Loamy sand	1" per week
Sandy loam	1" per week
Loam	1" per week

Resources

State cooperative extension services: http://www.csrees.usda.gov/Extension/index.html

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Maximize Irrigation System Efficiency

If an irrigation system is in place, focus on strategies that maximize irrigation system performance and efficiency. Sustain the landscape by updating irrigation systems according to the dynamic water needs of turf and ornamentals. Incorporate evapotranspiration (ET) and precipitation data in irrigation scheduling. Develop an efficient irrigation system by using data from audits.

Irrigation controllers and systems should include the following features:

- ❑ Flow Sensor- capable of monitoring how much water is being used and communicating this to a controller with a master valve.
- ❑ Master valve- able to shut down zones or systems due to unscheduled flow conditions, main line brakes, or increased flows due to broken sprinkler heads.
- ❑ Rain Sensor- shut off controller due to rain.

- Remote Hand Controller- very useful tool to assist with sprinkler head and maintenance inspections.
- Central Control Irrigation Controller with ET incorporated data (only when maintenance is properly trained and can support this technically advanced and beneficial system).

Perform regular inspections to optimize irrigation equipment. It is good practice to perform in-depth inspections of irrigation systems after annual activation in the spring, and bring systems up to specified operating conditions. Components to consider include:

- Water valves: (1) Adjusted for proper flow and operation and (2) To ensure proper shutdown of valves.
- Sprinkler heads: (1) Adjusted properly and (2) Cleaned to remove debris that might cause blockage or buildup.
- Sensors: (1) Adjusted properly and (2) Calibrated according to specifications.

If and when irrigation water runs onto hardscape such as sidewalks, streets, or driveways, immediately shut off irrigation systems and adjust. Look for signs of leakage, such as overgrown or particularly green turf areas, soggy areas around spray heads and aboveground hoses, jammed spray heads and torn hoses.

Adjust water pressure as needed. Make sure that water pressure is properly set to minimize wind effects. Make sure that the water supply and pressure meet design specifications. Differences in the sprinkler system‘s required design operating pressure and actual water pressure can affect operation and efficiency. Install pressure reducing valves (PRVs) where needed to stop misting due to excessive pressure.

Regularly update and adjust the irrigation system in response to the changing/seasonal landscape water needs using specific measures, which include:

- Modify and inspect automatic controllers according to the seasonal needs of plants.
- Understand and use a reliable source for reference evapotranspiration rates. Appropriately modify the reference evapotranspiration to calculate local water needs for the needs for the various plant materials and turfgrass in the landscape. Use the California Irrigation Management Information System (CIMIS) for accurate evapotranspiration data (www.cimis.water.ca.gov) Local water providers may also supply evapotranspiration data.
- Periodically verify that plant material is healthy and that soil moisture is adequate. Use a soil probe to visually inspect root depth, soil structure and moisture.
- The irrigation system is a management tool and cannot replace the sound judgment of trained professionals. The best-designed irrigation system will fail without regular maintenance.

Resources

American Society of Landscape Architects (ASLA): http://www.asla.org/nonmembers/sewin.cfm.

Boston Schoolyard Initiative: http://www.schoolyards.org.

Green Industries of Colorado, Best Management Practices for the Conservation and Protection of Water Resources: http://www.greenco.org/bmp_list.htm.

Greening School grounds: http://www.greengrounds.org.

National Clearinghouse for Educational Facilities, Resource List – Water Conservation in Schools: http://www.edfacilities.org/rl/water.cfm.

Professional Grounds Management Society: http://www.pgms.org/.

Sports Turf Managers Association: http://www.sportsturfmanager.com/.

University of Massachusetts, Plant Culture and Maintenance: http://www.umassgreeninfo.org/fact_sheets/plantculture.html.

Water Systems on School Grounds: http://www.ecoschools.com/Water/Water_wSidebar.html.

CHPS Best Practices Manual, vol. 4, Guideline LP7: Irrigation Systems: http://www.chps.net/

Indoor Water Systems

The growing value of potable water underscores the importance of lowering demand. Efficient water consumption naturally reduces the amount of water pumped from the ground or transported from reservoirs to cities and towns. In addition, water efficiency reduces the cost and amount of sewage needing treatment after use.

New requirements mandate the use of low-flow faucets and showerheads. Schools must provide proper training on water conservation so that devices are used properly. Students will find ways to tamper with devices if they are unhappy with the lower flow or unaware of the benefits. Providing training to the users is critical to the success of water conservation measures.

Ultra-low-flush (ULF) devices for toilets in urinals will significantly reduce water usage. It is important to distinguish low-flush from low-flow. Low-flush toilets and urinals may reduce the consumption per flush by reducing flush time; piping for these fixtures should be sized for the same flow rate. Assuming a lower flow rate in the design can lead to water hammer and other problems. Verify the recommended flow rate for low-flush devices.

Waterless urinals have the benefits of lower maintenance, since they do not use mechanical parts to flush and remove waste. Their low maintenance requirements are also an obstacle to their use: since they do not require the same daily cleaning procedure, odors can develop before the cartridges require replacement. Also, in some larger districts irrigation has a large impact on water usage and may be a better focus for water conservation programs.

Fixtures

Routine maintenance should be performed on all terminal devices and associated piping. Such devices include drinking fountains, sinks, showerheads, emergency wash stations and kitchens. Maintenance procedures should include:

- ❑ Check piping monthly for leaks, corrosion or signs of deterioration. Check insulation on pipes prone to condensation. Fix any leaks as soon as possible to prevent water damage and pest attraction.
- ❑ Check the seals of all fittings and valves for leaks, scaling or other signs of deterioration.
- ❑ Check drainage piping for blocked lines. Check water piping joints – corrosion build-up may occur if there is a pH imbalance or improperly joined metals.

- Verify that shut-off valves and backflow devices are fully operational for all equipment. Verify that emergency shut-off valves for gas-fired equipment in kitchens and labs and for gas-fired water heaters are functioning properly.
- Clean showerheads to remove any accumulated mineral deposits.
- Consider using separate cleanouts for urinals and toilets, to minimize disturbance to the educational environment.
- Provide shutoff valves to isolate sections of the building when problems occur. Isolate group restrooms, building wings or groups of classrooms to minimize impacts of problems.
- Wall-mounted water closets that have blowout-design flush valves can reduce maintenance requirements.
- Activate eyewash and shower equipment at least monthly to flush the line and verify proper operation.
- Hot and cold-water piping systems are typically copper; steam and gas piping are usually constructed from malleable iron. School maintenance staff spend a lot of their time responding to stoppages and leaks of fixtures and fittings. With piping, problems occur most often with the fittings, the result of corrosion, erosion and mineral buildup. Water hammer can crack piping and cause leaks in header piping and heating coils. Discoloration (or rust, for steel pipes) may be one of the first noticeable signs of a small leak. Seldom exercised valves should be routinely checked, at least once a year, so that mineral deposits don't ~~l~~ock" them in place.

Science labs often have special plumbing requirements. Acid-resistant sinks and plumbing to accommodate acid waste may be required. Sinks should have (basket) strainers. Labs may require a natural gas shut-off valve for safety.

How to Clean and Maintain Waterless Urinals

A waterless urinal looks very much like a conventional urinal. Many times, all that is different is the missing flush valve or piping that normally sits above the unit (because waterless urinals, as the name implies, don't need water to operate).

Instead, waterless systems have a vertical-trap design that incorporates a cylinder or trap filled with a thin layer of liquid sealant sitting atop the drain area of the urinal. Urine passes through the cylinder and sealant; as the cylinder fills, it flows under the barrier layer and into the waste line, where it is drained - much the same way a conventional urinal works.

Since the urinal surface is dry, it helps inhibit bacteria growth and odor, and makes the unit easier to clean. Additionally, there are no water deposits or rust stains to build up as with a water-based urinal.

Although there are some differences depending on the manufacturer, cleaning a waterless urinal follows most of the same steps and procedures as a conventional urinal:

- Wear gloves (and goggles) to clean any restroom fixture.
- Remove any foreign objects in the urinal. The trap is designed to prevent larger objects from entering the drain area.
- Do not use abrasive cleaners, towels, or brushes.
- Mist all urinal surfaces with a neutral or all-purpose cleaner, or use a Johnny Mop with water and cleaner on all surfaces.

- ❑ Allow for dwell time (if indicated by the chemical manufacturer).
- ❑ Wipe clean with a soft sponge, a Johnny Mop dipped in a bucket of clean water, or a cleaning cloth.
- ❑ Dry the surfaces with a soft cloth.
- ❑ Do not pour excess or soiled water down the waterless urinal trap - it can flush the sealant out of the trap insert.

Sealant and Trap Replacement

In most cases, cleaning professionals are asked to handle the trap's maintenance. Although maintenance requirements may differ depending on the product, they usually involve replenishing the liquid sealant and/or replacing the cylinder as necessary.

As the urinal is used, small amounts of the sealant will be drained into the waste line and need to be replenished (usually after 1,500 uses). This typically amounts to one or two refills per month.

To add sealant, use the "portion aid" device that comes with the sealant; this will accurately measure the 3 ounces of sealant needed, which is poured directly into the cylinder.

The cylinder on some waterless urinals lasts several months and may only need to be changed 2 to 4 times per year. To replace the cylinder:

- ❑ Use the metal tool provided by the manufacturer to remove the trap.
- ❑ Insert it into the trap, gently pulling it out using a back-and-forth motion.
- ❑ Drain any excess liquids from the cylinder down the drain; discard in an appropriate manner.
- ❑ With the trap removed, pour a bucket of (preferably) hot water down the drain to flush any sediment in the line.
- ❑ Insert a new trap, add about 12 ounces of water, and fill with 3 ounces of sealant.
- ❑ For some manufacturers, the trap cannot be replaced and the trap needs to be taken apart and cleaned.

Resources

American Society of Plumbing Engineers: http://www.aspe.org

American Water Works Association. Provides information on drinking water standards and regulations, and information on cross connection control: http://www.awwa.org.

Arizona School Facilities Board, Maintenance Checklist. Contains a thorough list of preventive maintenance tasks, with recommended frequency, skill level, and the time that is required to complete each task. Downloadable Excel file:
http://www.azsfb.gov/sfb/agency/pages/formDoc.asp?theType=0&section=33&Go=Go

Collaborative for High Performance Schools, Best Practices Manual, Volume II – Design:
http://www.chps.net.

Fitzemeyer, Ted, "Construction Guide: Plugging Leaks", School Designs, 2004. Primedia Business Magazines & Media, a PRIMEDIA company:
http://www.schooldesigns.com/constr_PluggingLeaks.html.

Florida Department of Education, Maintenance and Operations Guidelines for School Districts and Community Colleges, Office of Educational Facilities, 1054 Turlington Building, 325 West Gaines Street, Tallahassee, Florida 32399-0400. Telephone: (850) 245-0494, SUNCOM: 205-0494, Fax: (850) 245-9236 SUNCOM: 205-9236: http://www.firn.edu/doe/edfacil/manoguid.htm.

National Clearinghouse for Educational Facilities, Resource Lists – Water Conservation in Schools: http://www.edfacilities.org/rl/water.cfm.

Plumbing & Drainage Institute, 800 Turnpike Street, Suite 300, North Andover, MA 01845 USA Phone: 1-978-557-0720, 1-800-589-8956, Fax: 1-978-557-0721, Email: info@PDIonline.org. This organization provides information on products and standards. http://www.pdionline.org.

CHPS Best Practices Manual, vol. 4, Guideline PM2: Fixtures: http://www.chps.net/

IX. Materials Selection and Specification

Cleaning Products and Equipment

Assessing the Needs of the Facilities

The first step in developing a Green Cleaning Strategy is to assess the overall needs of the facilities. This entails looking at the size and age of the facility, the floor and wall coverings, and the condition of each area. Special attention should be paid to the resources available versus the amount of space to be cared for, and the complexity of each task to be performed. It is very important to use cleaning products that contain less-toxic ingredients and to eliminate all products that put custodians and occupants at high risk.

Environmentally Preferable Purchasing (EPP)

The main focus of an EPP strategy is to reduce the impacts of a product or service on both health and the environment compared to similar products and services used for the same purpose. EPP is a simple recognition of the enormous technological advances found in many industries, including those which supply products used for cleaning schools by increasing the importance of health, safety and environmental attributes when making a ~~"b~~best value" purchasing decision. It also recognizes that many schools are currently using 50+ year old technologies, and while these products are not ~~"b~~ad" or placing people at imminent risk, there are newer, safer, better technologies available.

EPP is an important opportunity especially for schools and other buildings with sensitive populations (i.e., young children, asthmatics and those with chemical sensitivities).

A more comprehensive definition of EPP can be found in Executive Order 13101, located at: http://www.ofee.gov/eo/13101.htm or the Center for a New American Dream at: http://www.newdream.org/procure/.

"Green" Cleaners

Approximately 5 billion pounds of chemicals are consumed in the U.S. each year to clean and maintain institutional and commercial buildings, of which schools are a significant portion. The majority of these products are derived from non-renewable natural resources and for the vast majority of the 70,000+ ingredients used to make these products, little testing has been conducted to evaluate their long-term effects on children or the environment.

One way to find safer and environmentally preferable chemicals is to purchase products that have been Green Seal Certified, or have equivalent specifications. Executive Order 13101 provides a definition that is useful. The three Environmentally Preferable Products Purchasing ~~"w~~izards" produced by U.S. General Services Administration are helpful and can be found at: http://www.epa.gov/oppt/epp/cleaners/select/matrix.htm

Specific to standards for cleaning products, Green Seal, a non-profit, consensus-based standards setting organization, has produced widely adopted industry standards for sustainable, healthy and safe materials, cleaning supplies and their proper use. The Green Seal Standard for Industrial and Institutional Cleaners (see GS-37) address health, environmental & performance attributes.

By using Green Seal Standard 37, or an equivalent set of specifications, it is much easier to develop a cleaning product program for the needs of each school and school district as compared to a school district trying to develop its own unique specification addressing health, safety, environmental, performance and other criterion. Furthermore, when purchasing Green Seal Certified products a school can be confident that the product meets the health, environmental and performance requirements because Green Seal audits the manufacturer's facility to insure that they are doing what they claim. More information on Green Seal's Standard 37 can be found at http://www.greenseal.org/standards/industrialcleaners.htm.

It can also be helpful to find out what other cities, states, and other agencies are buying, but this may simply reflect temporary local vendor promotions or long-standing business practices. Another route is to evaluate and test the products onsite.

The typical custodial contractor buys its chemical products from a number of sources and keeps an inventory sufficient to cover about a month's consumption. Custodians working for a site also buy from a variety of sources, but can keep more supplies on hand. Some school districts purchase each fall enough supplies for an entire year. One desirable goal in purchasing is to establish a single source of compatible, environmentally friendly products that carry the Green Seal label. This is not just safe and healthy, but also good business, since buying in quantity allows for lower costs per unit volume purchased.

Product Ingredients

Preferable Ingredients

There are two critical elements in deciding when a product is environmentally preferable. The first critical element is choosing a product that has comparatively fewer human health and safety risks than others. The second critical element is to minimize or eliminate negative environmental impacts as much as possible. These elements form a decision-making model and can be developed using a decision matrix which takes advantage of the opportunity to reduce health risks to humans, create fewer environmental impacts, and allow custodians to perform their work more safely.

Incorporating environmentally preferable products into purchasing decisions requires a comparison based on health and environmental factors.

Ingredients to Avoid

According to the Pennsylvania Green Building Maintenance Manual, all-purpose cleaners consist of a broad array of possible formulations. The following are some of the specific issues to compare for this product category:

- pH: Prefer those with a neutral pH (closer to 7) as compared to those with extreme pH (closer to 1 or 14)
- Biodegradability: Prefer those that are readily biodegradable as compared to those that are slower to degrade. Unfortunately, many older formulations contain excellent performing ingredients that have been found to have serious environmental and health concerns.
- Dyes and fragrances: Prefer those with no or low levels of dyes and fragrances compared to those products that are heavily dyed or fragranced. If dyes are necessary use those that are approved for foods and cosmetics (F&C).

- Volatile organic compounds (VOCs): Prefer those that have no or low VOCs as compared to alternatives with higher levels. Consider detergent-based products compared to those containing solvents.
- Surfactants: More preferable surfactants are those containing terms such as lauryl, amides, and glycosides as they are sustainably derived from bio-based and renewable resources.
- Less preferable ingredients: Nonyl Phenol Ethoxylates, NTA, EDTA, glycol ethers, sodium hydroxide, potassium hydroxide, sodium metasilicate, and phosphates as these common ingredients each have some significant adverse health or environmental impact.

Minimize Product Use

Before using a product, an analysis must first be done as to whether the task for which the product is needed is a task that should be performed at all. Find out which products contain the most dangerous ingredients and focus on changing those first.

Next, do research to find out the alternative products that are available. Figure out how to perform the same work with fewer chemicals. Initially restrict the use of highest risk chemicals using a sign-out system to control inventories, and be sure to train custodians on how to minimize chemical use. Eliminate highest risk chemicals by shifting from the old products after finding, testing, and introducing preferable substitutes.

Safe Chemical Use, Storage and Disposal

- Read the label and directions for use, storage, and disposal. Hazard warning labels must include a description of the hazard(s), personal protection information and first aid for accidental exposure.
- Avoid skin and eye contact. Use appropriate personal protective equipment.
- Never mix products or different brands of the same product. Follow the instructions on the label.
- Keep products in their original containers if possible. If not, be sure that containers are properly labeled, and use a different color for each chemical to prevent accidental misuse of cleaning solutions.
- Buy the appropriate products for the job, in the appropriate quantity. Use non-hazardous or less hazardous products as described above.
- Provide adequate ventilation. For example, mixing of solutions or dilution procedures should take place in a well-ventilated area, negatively pressurized area, or outdoors.
- Store all cleaning materials in a well-ventilated closet, away from highly trafficked areas.

Aerosols

In most situations the use of aerosols indoors is not a sustainable, healthy or cost effective practice. The negative effects of most propellants and/or the high relative cost per unit of volume can be easily demonstrated in most cases. If they exist or are used, dispose of the empty containers in the trash—do not burn or put them into a trash compactor where they may rupture or explode. Some aerosol cans that are steel or aluminum are recycled in some areas of the U.S. Contact the local health department or refuse disposal facility to learn more about what

can be done in your area. Pump products are a non-aerosol alternative to most aerosol formulations.

- Aluminum cleaners. Although most schools do not purchase these types of cleaners, if they are used, treat them as follows: If they contain phosphoric acid and only a small quantity remains, they can be discarded in the septic system. Pour the product down a drain (not a storm sewer—some garage drains may empty into the storm sewer) and flush with plenty of water. Rinse the container and throw it away.
- Ammonia. DO NOT MIX WITH CHLORINE BLEACH. The product can be discarded in small quantities in the septic system, in the same method as aluminum cleaners.
- Bleach. DO NOT MIX WITH AMMONIA. The product can be discarded in small quantities in septic system, in the same method as aluminum cleaners.
- Detergents. The product can be discarded in small amounts down a sanitary drain, in the same method as aluminum cleaners.
- Drain openers. If the product contains a solvent (organic solvent), take it to a household hazardous waste collection program. In most cases, allowing the volatile solvents to evaporate is not recommended. State, and local rules and insurance policies should be carefully checked before considering evaporation, and if evaporation of solvents is allowed, it is only recommended in a ventilated chemical laboratory hood. Many types of chemical disposal programs for schools are becoming more common nationwide. Contact risk management, health agencies and environmental authorities for local guidance on disposal programs and facilities that will accept organic solvents from schools for proper disposal. If it does not contain a solvent, the product may the discarded in the same method as aluminum cleaners. Wear eye protection when discarding drain cleaners.
- Floor care products. If the product contains an organic solvent, it can be disposed of in the same method as either aerosols or drain openers. If the product does not contain a solvent, it can be discarded in the same method as aluminum cleaners.
- Furniture polish. The product can be disposed of in the same method as aerosols or by evaporating in the same method as drain openers.
- General home liquid cleaners. If the product contains a solvent, it can be disposed of in the same method as aerosols or drain openers. If the product does not contain a solvent, it can be discarded in the same method as aluminum cleaners.
- Germicides/disinfectants. If the product contains a solvent, it can be disposed of in the same method as aerosols or drain openers. If the product does not contain a solvent, it may be able to be discarded in the same method as aluminum cleaners. Save the product for a hazardous waste collection if "germicide or disinfectant" is listed in the ingredients. Technically, disinfectants or germicides fall under pesticide labeling regulations. Try to avoid disposal in septic systems.
- Metal polish with solvent. The product may be evaporated in the same method as aluminum cleaners.
- Oven cleaner. If the product contains a solvent, it can be disposed of in the same method as aerosols or drain openers. If the product does not contain a solvent and is not an aerosol, it can be discarded in the same method as aluminum cleaners.

- Rug upholstery cleaners. If the product contains a dry-cleaning solvent, it can be disposed of in the same method as aerosols or drain openers. If the product does not contain a solvent, it can be discarded in the same method as aluminum cleaners.
- Toilet, tub, and tile cleaners. The product may be discarded in the septic system, in the same method as aluminum cleaners.
- Window cleaner. The product may be discarded in the septic system, in the same method as aluminum cleaners. If the product contains a solvent, dispose of through evaporation.

Pollutant Source Control

Whenever possible it is best to keep chemical usage and storage isolated from the rest of the facility. This includes housekeeping areas, chemical mixing areas, copying/print rooms, photo labs, science labs, and vocational spaces. It is recommended that these areas be partitioned off, physically isolating activities associated with chemical contaminants from other locations in the building. Dedicated exhaust should be installed for a ventilation rate of at least 0.50 cubic feet per minute per square foot with adequate make-up air. The air from these areas should not be re-circulated, and negative air pressure should be maintained.

In photo-lab areas, table vents should be used to draw chemical vapors away from the breathing zone of darkroom users. Other high hazard areas including all housekeeping chemical storage and mixing areas should allow for locked secure product storage.

Resources

Ashkin, Stephen, "The All-Purpose Solution," American School and University, v76 n2, October 2003. This article discusses improved worker and student performance through improved cleaning practices. The author cites studies showing significant improvement in indoor air quality and improved health of occupants through deep-cleaning strategies. http://asumag.com/mag/university_allpurpose_solution/.

Bigger, Alan; Bigger, Linda, "Keeping it Clean by Going Green'," Maintenance Solutions, June 2003, This piece discusses how to integrate highly productive equipment with environmentally friendly and cost-effective products to enhance the level of cleanliness in restrooms. http://www.facilitiesnet.com/ms/jun03/jun03environment.shtml.

California Integrated Waste Management Board, Environmentally Preferable Purchasing: http://www.ciwmb.ca.gov/WPIE/Purchasing/.

Commonwealth of Pennsylvania, "Pennsylvania Green Building Maintenance Manual: A Manual for the Commonwealth of Pennsylvania on Environmentally Preferable Building Operations and Maintenance." April 1, 2002.

Green Seal: http://www.greenseal.org.

Healthy Schools Network Inc., Sanitizers and Disinfectants Guide. 773 Madison Avenue, Albany, NY 12208; Tel: 518-462-0632: http://www.healthyschools.org/guides_materials.html.

National Clearinghouse for Educational Facilities, Resource List – Cleaning and Maintenance Practices in Schools: http://www.edfacilities.org/rl/cleaning.cfm.

U.S. Environmental Protection Agency, Database of Environmental Information for Products and Services: http://yosemite1.epa.gov/oppt/eppstand2.nsf.

CHPS Best Practices Manual, vol. 4, Guideline CP2: Cleaning Products and Equipment: http://www.chps.net/

Maintaining Interior Surfaces

"Green" Janitorial Equipment

Schools use janitorial equipment, such as vacuum cleaners, floor buffers and burnishers to maintain carpeting and hard flooring materials. Studies have shown that the soils being removed by these pieces of equipment can be contaminated with toxic materials including lead, pesticides, VOCs, mold spores and other materials that can affect health. Unfortunately, some commonly used equipment can actually contribute to these problems.

Some of the problems which can be caused by these pieces of equipment include vacuum cleaners with poor quality cloth bags containing no inner liners that inadequately capture fine particles and can actually contribute to indoor air quality problems as they pull contaminants that would otherwise be trapped in a carpet and make them air-borne. Another example is high speed burnishers without filter attachments which grind floor finish off the floor and send them into the air to be inhaled and resettle as dust on furnishings and other services. Specifying and utilizing janitorial equipment that not only create a good appearance, but more importantly capture and remove dust is essential for maintaining a healthy school.

In order to avoid some of the health hazards listed above, cleaning equipment should meet the following requirements:

Vacuum Cleaners

- ❑ Vacuum cleaners should meet Carpet & Rug Institute Green Label Program. Information on the Green Label Program can be found at: http://www.carpet-rug.com. It is desirable that vacuums exceed the minimum requirements of the Green Label Program in the following ways:
- ❑ Higher ability to capture and contain fine/respirable particles (capture 96% of particulates 0.3 microns in size).
- ❑ Powerful air flow (>90 CFM) and suction (static lift of >80 inches) for enhanced cleaning performance.
- ❑ Durable to reduce impacts on Resources and disposal (manufacturer's warranty on parts and labor >2 years).
- ❑ Carpet extraction equipment should be capable of removing sufficient moisture such that carpets can dry in less than 24 hours.

Other Surface-Cleaning Equipment

- ❑ Powered floor maintenance equipment should be equipped with vacuums, guards and/or other devices for capturing fine particulates, and shall operate with a sound level less than 70dBA.
- ❑ Propane-powered floor equipment should have high-efficiency, low-emission engines.
- ❑ Automated scrubbing machines should be equipped with variable-speed feed pumps to optimize the use of cleaning fluids.

- ❑ Battery-powered equipment should be equipped with environmentally-preferable gel batteries.
- ❑ Where appropriate, active micro fiber technology should be used to reduce cleaning chemical consumption and prolong life of disposable scrubbing pads.

Schools should keep a log for all powered janitorial equipment. The log should identify the date of purchase and all repair and maintenance activities. Include vendor cut sheets for each type of equipment in use in the logbook.

All powered equipment including those for both hard floor and carpet care should be ergonomically designed to minimize vibration, noise and user fatigue. Additionally, consider weight, ease of motion, tools and accessories, and profile of equipment when evaluating ergonomically designed equipment.

Asbestos

Asbestos is a naturally occurring mineral fiber, once widely used in building materials for its thermal insulating properties and fire resistance. Although the removal of asbestos from school buildings is an option for schools, many schools and local education agencies have chosen to manage some asbestos-containing building material in place.

Intact, undisturbed asbestos-containing materials generally do not pose a health risk. These materials may become hazardous and pose increased risk if they are damaged, are disturbed in some manner, or deteriorate over time and release asbestos fibers into building air.

A number of building materials still in use today contain asbestos. Asbestos remains in use as an acoustic insulator, and in thermal insulation, fire proofing, roofing, flooring and other materials. There are several simple things you can do to minimize your exposure to asbestos. The most important one is to find out which materials in your school contain asbestos. Once you know where asbestos is, use special care to insure that any day-to-day activities, such as repair or maintenance work, do not disturb the material. In fact, special training is required to participate in any maintenance activities which might disturb asbestos. In schools, asbestos-containing materials can also be damaged by student activities. For example, an asbestos ceiling in a gym may be disturbed if basketballs or other objects are thrown up against it. Students and others who use the gym should be warned to avoid such activities.

Resources

US EPA: *The ABC's of Asbestos in Schools*: Published by the EPA, August 2003: www.epa.gov/asbestos/help.html

http://www.epa.gov/asbestos/pubs/asbestos_in_schools.html

CHPS Best Practices Manual, vol. 4, Guideline CP2: Cleaning Products and Equipment: http://www.chps.net/

Selecting Low Emitting Materials

Just as with selecting materials for the construction of a new school, selecting low emitting materials when adding furnishings, or renovating spaces can have significant impact on indoor air quality. Many common indoor building and surfacing materials contain a variety of potentially carcinogenic and/or toxic chemicals. These chemicals are released into the air and can cause a variety of health problems, from minor irritation to major health problems. Recent studies have

implicated volatile organic compounds (VOCs) as significant risk factors for asthma. Exposure to VOCs emitting from sources such as cleaning agents, solvents, furnishings, paint, flooring products, and building materials, may increase the risk of asthma and other ailments. This is especially important in schools because children are typically more sensitive to indoor air pollutants than adults.

Low VOC content should be specified for the following materials:

- ❑ Adhesives and sealants
- ❑ Acoustic ceiling tiles and acoustic wall panels
- ❑ Carpeting
- ❑ Interior paint
- ❑ Wall coverings (do not use vinyl wall paper)
- ❑ Solid and composite wood flooring
- ❑ Insulation installed interior to the building vapor barrier
- ❑ Resilient flooring

Resources

CHPS Products Database: https://www.chpsregistry.com/live/

Green Spec: http://www.buildinggreen.com

The following programs certify low VOC products:

Scientific Certification Systems Indoor Advantage – Gold:
http://www.scscertified.com/gbc/indooradvgold.php

Resilient Floor Covering Institute (RFCI) Floor Score: http://www.rfci.com/int_FS-ProdCert.htm

GREENGUARD Certification Program: http://www.greenguard.org/

Carpet and Rug Institute Program - Green Label Plus:
http://www.carpet-rug.org/commercial-customers/index.cfm

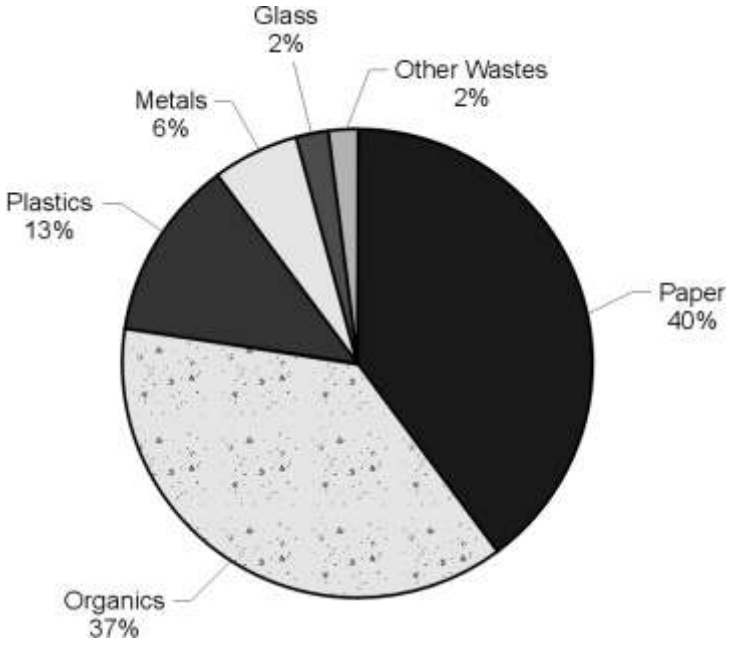
X. Recycling

Storage and Collection of Recyclables

The recycling of many common materials is promoted throughout the Northeast with a variety of recycling programs and services. Typical recyclables include aluminum cans, steel cans, newspaper, white paper, corrugated cardboard, single polymer plastics, and glass bottles. Place recycling bins next to trashcans to provides students, faculty and staff with disposal options, and reduce or prevent contamination of recycling bins with trash. Ensure that the recycling bins are marked clearly. Many recycling services can provide appropriate signage.

M&O staff should have a clear idea of the main types and amounts of waste that are generated on the school site. Recycling programs should target those areas. While many types of materials can and should be part of a school‘s recycling program, this guideline focuses on the three materials that are generally the most common waste types at schools: paper, plastics, and organic materials. Figure 5 shows a typical breakdown of school waste.

Figure 5 – Typical Breakdown of School Waste



Source: City of Los Angeles.

It is important that school staff and students are reminded on a regular basis of the proper items and the correct methods of preparation. Collected recyclables are a raw material for industry and therefore they must meet manufacturers‘ specifications just like any other raw material. Improperly prepared recyclables may lose value or become so contaminated that they cannot be recovered and must be disposed of as trash instead. For example, the addition of a broken ceramic cup to a load of glass containers at a glass recycling plant might result in rejection of the entire load. Recyclables contaminated with food residue may cause odor or pest problems.

Common Recycled Materials

Paper

Paper is generally the largest waste material generated at schools. Design your program to maximize both the quality and the quantity of waste paper collection. Consider installing a baler for cardboard and mixed paper to facilitate the management of some recyclables and to increase storage space.

Plastics

Schools generate a lot of plastic waste, mainly from food and beverage containers. Check with your local recycling service about plastics collection. Most services collect PET and HDPE plastic containers. It is important that staff knows which plastic types will be collected and which are not appropriate for recycling.

Figure 6 contains a list of various types of plastic.

Figure 6 – Plastic Types

NUMBERED CODE	NAME AND CHARACTERISTICS	ITEMS MADE FROM THIS PLASTIC	PRODUCTS MADE FROM THIS RECYCLED PLASTIC
1	**Polyethylene Terephthalate (PET):** Clear, strong, holds carbonation	Soft drink, beer, water, mouth wash, salad dressing and ketchup bottles and peanut butter containers	Fiber, tote bags, bottles, clothing, furniture, carpet and car upholstery
2	**High Density Polyethylene (HDPE):** Clear or bright colored	Milk, water and juice containers, trash bags, liquid detergent bottles, yogurt and margarine tubs	Liquid laundry detergent containers, drainage pipe, oil bottles, recycling bins, benches, pens, dog houses, vitamin bottles, floor tiles, picnic tables, lumber, mail box posts and fencing
3	**Vinyl (polyvinyl chloride or PVC):** Clear, strong, resistant to oil, grease and chemicals	Clear food packaging, shampoo bottles, medical tubing, wire and cable insulation	Packaging, binders, decking, paneling, roadway gutters, mud flaps, flooring, cable, speed bumps and mats
4	**Low Density Polyethylene (LDPE):** Clear, flexible, easy to shape	Bread bags, frozen food bags, some squeeze bottles, fiber, tote bags, clothing, furniture and carpet	Shipping envelopes, garbage can liners, floor tiles, furniture, compost bins, paneling, trash cans, landscape timber and lumber
5	**Polypropylene (PP):** Strong, chemical resistant, will not scratch	Ketchup bottles, yogurt containers, margarine tubs and medicine bottles	Auto battery cases, battery cables, brooms, brushes, ice scrapers, oil funnels, landscape borders, rakes, bins, pallets, bicycle racks and trays
6	**Polystyrene (PS):** Clear, rigid or foam	Compact disc jackets, grocery store meat trays, egg cartons, aspirin bottles, cups and plates	Thermometers, light switch plates, thermal insulation, egg cartons, desk trays, rulers and carryout containers
7	**Other:** Package is made with a resin other than the six listed above or of more than one resin used in combination	Three- and five-gallon water bottles, citrus juice and ketchup bottles	Plastic lumber and custom products

Source: South Carolina Department of Health and Environmental Control Office of Solid Waste Reduction and Recycling.

Organic Material

Organic materials make up more than one-third of a typical school's waste production. Schools can divert a significant amount of that material from the waste stream by:

- ❑ Collecting grass clippings and other yard waste in bins to be picked up by local green waste recyclers.
- ❑ Donating excess food not served to students to local shelters or food assistance programs.
- ❑ Storing food waste in special bins that can be sent to composting facilities and/or local farms where it can be used as feed for livestock. Also consider implementing onsite composting and/or vermicomposting (composting with worms).

Mercury

Recycle spent fluorescent lamps properly to reduce risk of exposure to hazardous wastes. Fluorescent lamps contain mercury, which is released into the atmosphere when tubes are broken in trash. Collecting them in their original containers and shipping them to a fluorescent lamp recycler reduces the risk of exposure to hazardous wastes.

A searchable database of facilities nationwide where you can take lamps and other equipment containing mercury to get recycled can be found at the following website: http://earth911.com/

Other Materials

Provide separate collection bins for glass and aluminum containers generated from food preparation, vending machines, and packed lunches, if your recycling service is not single stream. Almost all glass food and beverage containers, as well as scrap metal, lumber, concrete and asphalt are recyclable.

Monitoring

Monitoring is important for the success of all waste management and recycling programs. Annually, waste collection and recycling services should be evaluated to determine if either or both need to be reduced or increased, as well as to track the amounts of recyclables being collected. Such monitoring can help schools document their success in diverting materials from the landfills and saving district money on waste collection.

Recycling station at New Hampshire school

Resources

Broward County Public Schools Recycling Program, Broward County, Florida: http://www.broward.org/iwi03300.htm.

California Integrated Waste Management Board. School Waste Management Education and Assistance: http://www.ciwmb.ca.gov/schools/.

Environmental Protection Agency. WasteWise Program (5306W): U.S. Environmental Protection Agency; Ariel Rios Building; 1200 Pennsylvania Avenue, N.W.; Washington, DC 20460. Website: http://www.epa.gov/wastewise/wrr/prevent.htm.

Earth 911. Find Recycling Centers: http://earth911.com/

Northeast Recycling Council: http://www.nerc.org/

California Integrated Waste *Management Board Recycling Space Allocation Guide:* http://www.ciwmb.ca.gov/publications/localasst/31000012.doc

Technical assistance is available from the Northeast Resource Recovery association: http://www.recyclewithus.org/ and the following state contacts:

Connecticut Department of Environmental Protection: http://www.dep.state.ct.us/wst/recycle/ctrecycles.htm

Maine State Planning Office Waste Management and Recycling Program: http://www.state.me.us/spo/recycle/

Massachusetts Department of Environmental Protection: http://www.mass.gov/dep/recycle/recycle.htm

New Hampshire Department of Environmental Services: http://des.nh.gov/organization/divisions/waste/index.htm

Rhode Island Resource Recovery Corporation: http://www.rirrc.org/

Vermont Agency of Natural Resources: http://www.anr.state.vt.us/dec/wastediv/R3/recycle.htm

CHPS Best Practices Manual: vol. 4: Guideline ED3: Recycling: http://www.chps.net/

XI. Landscaping to Reduce "Heat Island Effect"

Although the "heat island effect" is largely an urban phenomenon, dark surfaces, such as pavement, cladding, and roofing absorb heat and radiate it back to surrounding areas. In cities, where there are many dark, heat absorbing surfaces, infrared radiation can boost temperatures by 10ºF or more. The heat island effect increases the need for air conditioning (and therefore electricity consumption) and is detrimental to site plantings, local wildlife, and maintaining comfortable temperatures.

Employing design strategies, materials, and landscaping designs that reduce heat absorption of exterior materials, will help to keep surrounding cool in urban environments. Recommended strategies include:

- ❑ Provide shade using native or climate-tolerant trees and large shrubs, vegetated trellises, or other exterior structures supporting vegetation
- ❑ Substitute vegetated surfaces for hard surfaces
- ❑ Explore the elimination of blacktop with the use of new coatings with integral colorants to achieve light colored surfaces

Resources

CHPS Best Practices Manual, vol. 2, Guideline GC4: http://www.chps.net/

US EPA, Heat Island Effect: http://www.epa.gov/heatisld/

Glossary

ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers.

ASTM – American Society for Testing and Materials.

B-20 –The term for a blend of 20% renewable bio-derived diesel fuel with 80% petroleum-based diesel fuel.

biodiesel – A domestic, renewable fuel for diesel engines derived from natural oils like soybean oil, which meets the specifications of American Society for Testing and Materials D 6751. Biodiesel is not the same thing as raw vegetable oil. It is produced by a chemical process that removes the glycerin from the oil.

biogas – Gas, rich in methane, which is produced by the fermentation of animal dung, human sewage, or crop residues in an airtight container. It is used as a fuel to heat stoves and lamps, run small machines, and generate electricity. The residues of biogas production can be used as a low-grade organic fertilizer.

bio-oil – A liquid created from biomass (see below) found in forestry and agricultural residues. The biomass is thermochemically converted to bio-oil by using processes called direct liquefaction or fast pyrolysis. The high water and oxygen content of bio-oils reduces their heating value to less than half the value of petroleum. However, bio-oils are low in viscosity and have been successfully burned in boilers, kilns, turbines, and diesel engines.

biomass –Any biological material that can be used as fuel. Biomass fuel is burned or converted in systems that produce heat, electricity, or both. In this document, biomass-fired systems refer to systems that are fueled by clean wood chips from forestry or saw mill operations.

brownfields –Industrial or commercial property that is abandoned or underused, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

CSI – Construction Specifications Institute.

CHPS – Collaborative for High Performance Schools.

COM*check* –Software developed by the U.S. DOE to help commercial projects demonstrate compliance with all commercial energy code requirements for envelope, lighting, and mechanical systems. For more information, see http://www.energycodes.gov/comcheck/.

commissioning – A systematic process of ensuring that all building systems perform interactively according to the contract documents, the design intent, and the schools operational needs. Commissioning involves three phases: pre-design, construction, and warranty.

commissioning plan – A plan that includes a list of all equipment to be commissioned, delineation of roles for each of the primary commissioning participants, and details on the scope, timeline, and deliverables throughout the commissioning process.

cool roof – A roof that reflects most of the sun‘s energy instead of absorbing it into the interior spaces below.

daylighting –The practice of placing windows and reflective surfaces so that the natural light of day provides effective internal illumination. Optimize the daylighting design to minimize glare and eliminate direct-beam light in the classroom and use daylighting controls designed to dim or turn off electric lights when sufficient daylight is available.

design-build – A construction-project delivery process in which a single entity assumes the obligation of furnishing the design, supervision, and construction services required to complete a project.

DOE-2 – Software that was developed by the U.S. DOE to predict the fuel consumption (both electric and fossil fuel) of a building based on its design. Later iterations include DOE 2.2, a more advanced form of the original software.

DOE-2.1E – An updated version of DOE-2 software.

e-QUEST – (**Qu**ick **E**nergy **S**imulation **T**ool) – Sophisticated software that allows for detailed energy analysis of a designed building. It also allows users to build 2-D and 3-D displays of the building geometry.

ENERGY STAR- A program that maintains a database of compliant manufacturers and products. Partial list of products include computers, monitors, copy machines, water coolers, printers, scanners, refrigerators, and washing machines.

gray water system – Water that has been used in showers, sinks, and laundry machines that may be reused for other purposes, especially landscape irrigation. Toilet water is not used in this system.

greenfields- Parcels of land not previously developed beyond that of agriculture or forestry use. The opposite of brownfield.

heat island – An effect caused when exterior surfaces absorb the sun‘s energy and heat the air near the ground. On a school site, rising temperatures make the school‘s air conditioning work harder, increasing energy cost.

HEPA filters – High Efficiency Particulate Air filters

integrated pest management (IPM) – A sustainable approach to managing pests that minimizes economic, health, and environmental risks.

integrated design – The consideration and design of all building systems and components. It brings together the various disciplines involved in designing a building and reviews their recommendations as a whole. It also recognizes that each discipline‘s recommendation has an impact on other aspects of the building project.

life cycle costing – A means of calculating and comparing different designs, equipment, and products to identity the best investment.

recycled content – Materials that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process (pre-consumer) or after consumer use (post consumer).

OSHA – Occupational Safety and Health Administration.

operations and maintenance manual – Provides detailed operations and maintenance information for all equipment and products used in the school.

operations and maintenance training – Provides a short introduction on operations and maintenance of equipment and products for all school staff and then features hands-on workshops for facility personnel.

potable water – Water of sufficient quality to serve as drinking water.

PowerDOE – Software that allows users to detail the predicted energy consumption of a building. Like e-QUEST, it is very graphical in its presentation of both the building description and the display of results. It includes 2-D and 3-D displays of the building geometry.

rain water collection system – A system that supplies water year round by harvesting both potable and non-potable water.

rapidly renewable materials – Materials that substantially replenish themselves faster than traditional extraction demand (e.g., planted and harvested in less than a 10-year cycle), do not result in significant biodiversity loss or increased erosion, positively impact air quality, and can be sustainably managed. Products in this category include, but are not limited to, bamboo products, wheat grass cabinetry, oriented strand board, and other wood products made from fast-growing pine trees.

responsibly produced – Materials that are extracted, harvested, or manufactured in an environmentally friendly manner (includes certified wood products).

retro-commissioning - Retro-commissioning (RCx) is a systematic, documented process that identifies low-cost operational and maintenance improvements in existing buildings and brings the buildings up to the design intentions of its current usage.

salvaged or reused – Materials that are refurbished and used for a similar purpose rather than processed or remanufactured for different use.

thermal comfort – A condition of mind that expresses satisfaction with the surrounding environment. It is determined by taking into account environmental factors (such as humidity, A/C, heat) and personal factors (what an occupant is wearing).

VisualDOE – Energy modeling software that is based on DOE-2 and allows users to evaluate energy and demand impacts of design alternatives.

VOC – Volatile Organic Compounds

wetlands –Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support vegetation adapted for life in saturated soil. Wetlands generally include swamps, marshes, bogs, and other similar areas.

Appendix A: Financial Implications of School Operations and Maintenance

Deferring maintenance projects can actually cost a school more in the long run as repairs become more critical and costly – whereas a dollar spent today can save several dollars over time. However, the American Association of School Administrators recently reported that ~~the~~ %age of schools deferring maintenance increased from 21 % in 2008-09 to 33 % in 2009-10." As school budgets shrink, operations and maintenance costs are often cut. Understanding the financial benefits of a comprehensive operations and maintenance plan is critical for school districts in the current economic climate. The following resources provide data and information about the financial impacts of such programs.

Recommended Reading:

~~L~~ooking Back, Looking Forward: How the Economic Downturn Continues to Impact School Districts," American Association of School Administrators, March 2009: http://aasa.files.cms-plus.com/PDFs/Publications/LookingBackLookingForward%20FINAL.pdf

~~R~~eview of Deferred Maintenance in the Commonwealth of Virginia," The Auditor of Public Accounts, December 2004: http://marketing.schooldude.com/marketing/LandingPageDocs/Planning/REVIEW%20OF%20DEFERRED%20MAINTENANCE_VA%20COMMONWEALTH.pdf

~~R~~epair for Success: An Analysis of the Need and Possibilities for a Federal Investment in PK-12 School Maintenance and Repair," The 21st Century School Fund, November 2009: http://marketing.schooldude.com/marketing/LandingPageDocs/Planning/PreK-12%20Maintenance%20Repair%20Renewal%20Investment_21CSF.pdf

~~2~~009 Infrastructure Fact Sheet", The American Society of Civil Engineers: http://marketing.schooldude.com/marketing/LandingPageDocs/Planning/RC2009_schools.pdf

Many additional resources can be found here:

National Clearinghouse for Educational Facilities, School Maintenance and Operations Costs Resources List: http://www.edfacilities.org/rl/mo_costs.cfm

Appendix B: Resource List

I. Establishing Operations and Maintenance Policies

Establishing an Indoor Environment Management Plan

EPA: Region I Environmental Protection Agency: Northeast office in Boston: Massachusetts: phone: (888) 372-7341; http://www.epa.gov/iaq/schools

Develop Master Maintenance and Staff Training Plan

Facility Operating Plan Template from Vermont Superintendent's Association: http://www.vtvsa.org/school-energy-management-program.php

Train and Certify Facilities Personnel Through a Comprehensive O&M Training Program such as the Building Operator's Certification Program

BOC Web site: http://theboc.info/index.html

BOC Informational Webcast: http://theboc.info/infowebcast_form.html

BOC Training Schedule in the Northeast: http://www.theboc.info/ne/schedule_ne.html

State of Rhode Island Training Programs: http://www.energy.ri.gov/programs/outreach.php

Public Service of New Hampshire Workshops: http://www.psnh.com/Business/Commercial/Workshop_frame.asp

Efficiency Maine Training Programs: http://www.efficiencymaine.com/education_programs.htm

State of Connecticut Training Programs: http://www.ctenergyinfo.com/index.htm

Massachusetts Facilities Administrators Association: http://www.massfacilities.org/

NSTAR Electric Training Programs: http://www.nstar.com/business/energy_efficiency/seminars/default.asp

National Grid Training Programs: http://www.nationalgridus.com/masselectric/business/energyeff/3_training.asp

Specifying Equipment Performance Levels for Appliances

ENERGY STAR: http://www.energystar.gov/

Plug Load Action Plan Template (EnergySmart Schools): http://apps1.eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess_plug-loads-template.pdf

Guide to Operating and Maintaining EnergySmart Schools: http://apps1.eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess_o-and-m-guide.pdf

Anti-Idling Policies

Asthma Regional Council Web site: http://www.asthmaregionalcouncil.org/about/BusToolkit.htm

Sample Policy:
http://www.asthmaregionalcouncil.org/about/documents/SchoolBusNoIdlingPolicy7.29.04.doc

Establishing an Alternative Fueled Vehicle and Equipment Program

EPA: http://www.epa.gov/cleanschoolbus/

International Council for Local Environmental Initiatives (ICLEI): http://www.icleiusa.org/action-center/learn-from-others/clean-school-bus-initiative-biodiesel-toolkit

Maintaining Bicycle and Walking Access to the Facility

The National Center for Safe Routes to School offers information on walking and biking to school: http://www.saferoutesinfo.org/

/nternational Walk to School provides information on encouraging safe walking and biking to school: http://www.walktoschool-usa.org/

Phasing-out the use of CFC and HCFC-based Refrigerants

Greening your Refrigerants; USGBC:
http://www.fmlink.com/ProfResources/Sustainability/Articles/article.cgi?USGBC:200607-25.html

U.S. EPA Refrigerant Guidelines and Regulations:
http://www.epa.gov/Ozone/title6/608/index.html

Utilizing School Facilities as Teaching Tools

The Apeiron Institute‘s Schools Programs: http://www.apeiron.org/new/education/index.php

Cape Light Compact‘s Energy Education Program:
http://www.capelightcompact.org/teachers.html

The Maine Energy Education Program (MEEP): http://www.meepnews.org/

The National Energy Education Development Project (NEED): http://www.need.org - Their catalog of materials may be downloaded at http://www.need.org/needpdf/Catalog.pdf

The U.S. Department of Energy: http://www1.eere.energy.gov/education

The Vermont Energy Education Program (VEEP): http://www.veep.org/

Utilizing Computerized Maintenance Systems

The Website Maintenance World,

http://www.maintenanceworld.com/CMMS-software.htm

SchoolDude: http://www.schooldude.com/

MicroMain™ software: http://www.micromain.com/educationK12.asp

NetFacilities maintenance management software: http://www.netfacilities.com/

CMMS software: http://www.cmmssoftware.org/

National Institute of Building Sciences: Computerized Maintenance Management Systems:
http://www.wbdg.org/om/cmms.php

II. Indoor Environmental Quality

Facilitating and Maintaining Daylighting Performance

CHPS Best Practices Manual: vol. 2: –Daylighting and Fenestration Design" chapter: www.chps.net

Lighting Research Center: http://www.lrc.rpi.edu/researchAreas/daylighting.asp

Pacific Gas and Electric Daylight Initiative: http://www.pge.com/pec/daylight/daylight.shtml

Heschong Mahone Group: Inc.: Daylighting Studies: http://www.h-m-g.com/

Maintaining the Ventilation System with a Goal of Meeting ASHRAE Standard 62.1-2004 for Indoor Air Quality

The American Society of Heating: Refrigerating and Air-Conditioning Engineers: http://www.ashrae.org/

Revised Standard 62.1 2007: http://www.ashrae.org/publications/detail/16403

Provide and Maintain Walk-Off Systems

American School & University article focusing on walk-off mats: http://asumag.com/mag/university_keeping_clean/

Environmental Design And Construction Magazine: CleanZone Matting System - http://www.edcmag.com/Articles/Feature_Article/28fa46a3ab697010VgnVCM100000f932a8c0_

Cleanlink: http://www.cleanlink.com/sm/article/Matting-Leaving-Dirt-At-The-Door--9209

Reference article on money savings associated with this type of walk-off system: http://www.mcmorrowreport.com/sfm/articles/mats.asp

National Floor Safety Institute: http://www.nfsi.org/splash.php

Replace HVAC Filters on a Schedule

Furnace Filter Care is an independent website with extensive information on filters: http://www.furnacefiltercare.com

Engineers' Edge article on filter types and performance: http://www.engineersedge.com/filtration/air_filter_types.htm

Selecting and Upgrading HVAC Filters

Maintenance World Article on selecting filters: http://www.maintenanceworld.com/Articles/plantengineering/hvac-attack.htm

Furnace Filter Care is an independent website with extensive information on filters: http://www.furnacefiltercare.com/merv-ratings.php

Engineers' Edge article on filter types and performance: http://www.engineersedge.com/filtration/air_filter_types.htm

Maintaining Energy Recovery Ventilation Systems

ACEEE research paper on commercial ERV systems: http://www.aceee.org/emertech/2009_CommVent.pdf

Sustainable Sources website article on ERVs: http://energyrecoveryvent.sustainablesources.com/

Contracting Business website ERV maintenance article:
http://contractingbusiness.com/service/cb_imp_6051/

Minimizing Mercury Exposure

United States EPA

http://www.epa.gov/mercury/about.htm

http://www.epa.gov/waste/hazard/tsd/mercury/con-prod.htm#industry

http://www.epa.gov/epawaste/hazard/wastetypes/universal/lamps/index.htm

http://www.epa.gov/epawaste/hazard/wastetypes/universal/lamps/recycle.htm

Other Resources

http://www.lightingdesignlab.com/articles/mercury_in_fl/mercurycfl.htm

http://www.lamprecycle.org/

III. Integrated Pest Management

EPA: IPM for Schools: A How-to Manual:
http://www.epa.gov/pesticides/ipm/schoolipm/index.html

State and Regional IPM Coordinators:
http://www.epa.gov/pesticides/ipm/ipmcontacts.htm#region1

Safer Schools IPM Guide including several case studies:
http://www.beyondpesticides.org/schools/publications/IPMSuccessStories.pdf

IV. Energy Efficiency

Understanding and Quantifying Energy Usage Benchmarking Facility Energy Usage

ENERGY STAR Portfolio Manager: www.energystar.gov/benchmark

DOE – Energy Smart Schools program:
http://www1.eere.energy.gov/buildings/energysmartschools/

Utility and Government Supported Energy Efficiency Programs: Cape Light Compact:
http://www.capelightcompact.org/

Connecticut Light and Power: http://www.cl-p.com/

Efficiency Maine: http://www.efficiencymaine.com/

Efficiency Vermont: http://www.efficiencyvermont.com/pages/

National Grid. http://www.nationalgridus.com/

NSTAR Electric: http://www.nstaronline.com/business/

Public Service of New Hampshire: http://www.psnh.com/

United Illuminating: http://www.uinet.com/

Western Mass Electric: http://www.wmeco.com/

National Association of State Facilities Managers provides information of facility assessment including energy usage: http://www.nasfa.net/

Implementing a Master Energy Efficiency Plan

Core Performance Guide by New Buildings Institute, Inc. 2007 edition: http://www.newbuildings.org.

ANSI/ASHRAE/IESNA Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential

Buildings: American Society of Heating: Refrigerating: and Air-Conditioning Engineers: Inc.: Atlanta: GA: 1999: 2001: 2004: http://www.ashrae.org.

ENERGY STAR – a federal-government-sponsored program helping businesses and individuals protect the environment through superior energy efficiency: http://www.energystar.gov/

DOE – Energy Smart Schools program: http://www1.eere.energy.gov/buildings/energysmartschools/

Cape Light Compact: http://www.capelightcompact.org/

Connecticut Light and Power: http://www.cl-p.com/

Efficiency Maine: http://www.efficiencymaine.com/

Efficiency Vermont: http://www.efficiencyvermont.com/pages/

Long Island Power Authority (LIPA): http://www.lipower.org

Massachusetts Clean Energy Center: http://www.masscec.com/

National Grid: http://www.nationalgridus.com/

New Hampshire Electric Co-op: http://www.nhec.com/

NSTAR Electric: http://www.nstaronline.com/business/

NYSERDA: http://www.nyserda.org/

Public Service of New Hampshire: http://www.psnh.com/

United Illuminating: http://www.uinet.com/

Western Mass Electric: http://www.wmeco.com/

Maintaining the Building Envelope for Energy Efficiency & Occupant Health

U.S. Environmental Protection Agency: Tools for Schools: Inspection Guidelines http://www.epa.gov/iaq/schools/actionkit.html

The Air Barrier Association of America: http://www.airbarrier.org

National Inspection Services: "Tips for Inspecting and Maintaining a Commercial Property": http://www.nationalinspection.net/inspector/articles/tips_commercial.html.

http://www.energysavers.gov/your_home/energy_audits/index.cfm/mytopic=11190

Maintaining and Retrofitting Lighting Systems

Consortium for Energy Efficiency (CEE): http://www.cee1.org/

Illuminating Engineering Society of North America: http://www.iesna.org/

Advanced Lighting Guidelines, New Buildings Institute: http://www.newbuildings.org/lighting.htm

Reducing or Eliminating Night-time Security Lighting

International Dark Sky Association: www.darksky.org/

Britain's Royal Commission on the Environment has published a report titled: Artificial Light in the Environment: http://www.rcep.org.uk/reports/sr-2009-light/sr-light.htm

The National Institute of Justice Report to Congress: Preventing Crime, What Works: What Doesn't, What's Promising: http://www.ncjrs.gov/works/

Maine Legislature Dark Skies Report
http://docs.darksky.org/Reports/Maine%20Final%20dark%20skies%20report.pdf

V. Alternative and Renewable Energy Systems

Biomass Systems

ASHRAE standard 55: http://www.ashrae.org

US DOE: "Guide To Operating and Maintaining Energy Smart Schools":
www.eere.energy.gov/buildings/energysmartschools/

FEMP boiler maintenance recommendations:
http://www1.eere.energy.gov/femp/operations_maintenance/om_boilers.html

FEMP steam trap information:
http://www1.eere.energy.gov/femp/operations_maintenance/om_stmaintenance.html

New England Fuel Institute: http://www.nefi.com/

National Biodiesel Board: http://www.biodiesel.org/

The Massachusetts Biodiesel Heating Fuel Program:
http://massenergy.com/MECA_BIOIL/index.htm

University of Georgia Engineering Outreach Service: "A Demonstration of Fat and Grease as Industrial Boiler Fuel":
http://outreach.engineering.uga.edu/services/Final%20Biofuel%20Oil%20Report%20-%20Executive%20Summary.pdf

The Biomass Energy Resource Center (BERC) in Montpelier, Vermont is an independent, national nonprofit organization that offers information and assistance regarding biomass systems: http://www.biomasscenter.org/

Wood Chip Heating Systems and *Vermont Fuels for Schools* are both useful guides to wood-fired systems and are downloadable at this address:
http://www.biomasscenter.org/resources/publications.html

Massachusetts Division of Energy Resources: *Wood Pellet Heating: A Reference on Wood Pellet Fuels & Technology for Small Commercial & Institutional Systems:*
http://www.mass.gov/Eoeea/docs/doer/publications/doer_pellet_guidebook.pdf

Maintaining Solar Thermal and Photovoltaic (PV) Systems

The Northeast Sustainable Energy Association (NESEC): http://www.nesea.org/

Solar Energy Industries Association: http://www.seia.org/

The Florida Solar Energy Center: http://www.fsec.ucf.edu

Solar Industry Magazine publishes many online articles concerning the maintenance of solar systems: http://www.solarindustrymag.com

Site Installed Wind Systems

American Wind Energy Association: http://www.awea.org/

The Northeast Sustainable Energy Association (NESEC) maintains a searchable library of renewable energy resources: http://www.nesea.org/

World Wind Energy Association: http://www.wwindea.org

VI. Commissioning and Retro-commissioning

Building Commissioning Association Certification Program: http://www.bcxa.org/certification/index.htm

ASHRAE Commissioning Process Management Professional (CPMP) program: http://www.ashrae.org/certification/page/2086

CHPS Best Practices Manual, vol. 2, Guideline GC5, Contractor's Commissioning Responsibilities: http://www.chps.net/

ASHRAE Guideline 1-1996, The HVAC Commissioning Process and ASHRAE Guideline 4-1993, Preparation of Operations & Maintenance Documentation for Building Systems: http://www.ashrae.org.

VII. School Bus Maintenance

Asthma Regional Council of New England – Clean Buses Initiative: http://asthmaregionalcouncil.org/indoor-and-ambient-air-quality

US-DOE Fuel Economy Information: http://www.fueleconomy.gov/

School Bus Fleet Website: http://www.schoolbusfleet.com/Channel/Bus-Maintenance.aspx

VIII. Water Efficiency

Eliminate Irrigation for Non-Playing-Field Landscaping

State cooperative extension services: http://www.csrees.usda.gov/Extension/index.html

Maximize Irrigation System Efficiency

American Society of Landscape Architects (ASLA): http://www.asla.org/nonmembers/sewin.cfm.

Boston Schoolyard Initiative: http://www.schoolyards.org.

Green Industries of Colorado, Best Management Practices for the Conservation and Protection of Water Resources: http://www.greenco.org/bmp_list.htm.

Greening Schoolgrounds: http://www.greengrounds.org.

National Clearinghouse for Educational Facilities: http://www.edfacilities.org/rl/water.cfm

Professional Grounds Management Society: http://www.pgms.org/.

Sports Turf Managers Association: http://www.sportsturfmanager.com/.

University of Massachusetts, Plant Culture and Maintenance: http://www.umassgreeninfo.org/fact_sheets/plantculture.html.

Water Systems on School Grounds: http://www.ecoschools.com/Water/Water_wSidebar.html.

CHPS Best Practices Manual, vol. 4, Guideline LP7, Irrigation Systems: http://www.chps.net/

American Society of Plumbing Engineers: http://www.aspe.org

American Water Works Association: http://www.awwa.org.

Arizona School Facilities Board, Maintenance Checklist: http://www.azsfb.gov/sfb/agency/pages/formDoc.asp?theType=0&section=33&Go=Go

Collaborative for High Performance Schools, Best Practices Manual, Volume II – Design: http://www.chps.net.

Fitzemeyer, Ted, "Construction Guide, Plugging Leaks", School Designs, 2004. Primedia Business Magazines & Media, a PRIMEDIA company: http://www.schooldesigns.com/constr_PluggingLeaks.html.

Florida Department of Education, Maintenance and Operations Guidelines for School Districts and Community Colleges, Office of Educational Facilities, 1054 Turlington Building, 325 West Gaines Street, Tallahassee, Florida 32399-0400. Telephone: (850) 245-0494, SUNCOM: 205-0494, Fax: (850) 245-9236 SUNCOM, 205-9236: http://www.firn.edu/doe/edfacil/manoguid.htm.

National Clearinghouse for Educational Facilities, Resource Lists – Water Conservation in Schools: http://www.edfacilities.org/rl/water.cfm.

CHPS Best Practices Manual, vol. 4, Guideline PM2, Fixtures: http://www.chps.net/

VIII. Materials Selection and Specification

Cleaning Products and Equipment

Ashkin, Stephen, "The All-Purpose Solution," American School and University, v76 n2, October 2003. This article discusses improved worker and student performance through improved cleaning practices.

The author cites studies showing significant improvement in indoor air quality and improved health of occupants through deep-cleaning strategies. http://asumag.com/mag/university_allpurpose_solution/.

Bigger, Alan; Bigger, Linda, "Keeping it Clean by Going 'Green'," Maintenance Solutions, June 2003, This piece discusses how to integrate highly productive equipment with environmentally friendly and cost-effective products to enhance the level of cleanliness in restrooms. http://www.facilitiesnet.com/ms/jun03/jun03environment.shtml.

California Integrated Waste Management Board, Environmentally Preferable Purchasing: http://www.ciwmb.ca.gov/WPIE/Purchasing/.

Commonwealth of Pennsylvania, "Pennsylvania Green Building Maintenance Manual, A Manual for the Commonwealth of Pennsylvania on Environmentally Preferable Building Operations and Maintenance." April 1, 2002.

Green Seal: http://www.greenseal.org.

Healthy Schools Network Inc., Sanitizers and Disinfectants Guide. 773 Madison Avenue, Albany, NY 12208; Tel: 518-462-0632: http://www.healthyschools.org/guides_materials.html.

National Clearinghouse for Educational Facilities, Resource List – Cleaning and Maintenance Practices in Schools: http://www.edfacilities.org/rl/cleaning.cfm.

U.S. Environmental Protection Agency, Database of Environmental Information for Products and Services: http://yosemite1.epa.gov/oppt/eppstand2.nsf.

CHPS Best Practices Manual, vol. 4, Guideline CP2, Cleaning Products and Equipment: http://www.chps.net/

Asbestos

US EPA:

The ABC's of Asbestos in Schools: Published by the EPA: August 2003

www.epa.gov/asbestos/help.html

http://www.epa.gov/asbestos/pubs/asbestos_in_schools.html

CHPS Best Practices Manual, vol. 4, Guideline CP2, Cleaning Products and Equipment: http://www.chps.net/

Selecting Low Emitting Materials

CHPS Products Database: https://www.chpsregistry.com/live/

Green Spec: http://www.buildinggreen.com

The following programs certify low VOC products, Scientific Certification Systems Indoor Advantage – Gold: http://www.scscertified.com/gbc/indooradvgold.php

Resilient Floor Covering Institute (RFCI)Floor Score: http://www.rfci.com/int_FS-ProdCert.htm

GREENGUARD Certification Program: http://www.greenguard.org/

Carpet and Rug Institute Program: Green Label Plus: http://www.carpet-rug.org/commercial-customers/index.cfm

IX. Recycling

Broward County Public Schools Recycling Program, Broward County, Florida: http://www.broward.org/iwi03300.htm.

California Integrated Waste Management Board. School Waste Management Education and Assistance: http://www.ciwmb.ca.gov/schools/.

Environmental Protection Agency. WasteWise Program (5306W), U.S. Environmental Protection Agency; Ariel Rios Building; 1200 Pennsylvania Avenue, N.W.; Washington, DC 20460. Website: http://www.epa.gov/wastewise/wrr/prevent.htm.

Earth 911. Find Recycling Centers: http://earth911.com/

Northeast Recycling Council: http://www.nerc.org/

California Integrated Waste Management Board Recycling Space Allocation Guide: http://www.ciwmb.ca.gov/publications/localasst/31000012.doc

Technical assistance is available from the Northeast Resource Recovery association: http://www.recyclewithus.org/ and the following state contacts: Connecticut Department of Environmental Protection: http://www.dep.state.ct.us/wst/recycle/ctrecycles.htm

Maine State Planning Office Waste Management and Recycling Program: http://www.state.me.us/spo/recycle/

Massachusetts Department of Environmental Protection: http://www.mass.gov/dep/recycle/recycle.htm

New Hampshire Department of Environmental Services: http://des.nh.gov/organization/divisions/waste/index.htm

Rhode Island Resource Recovery Corporation: http://www.rirrc.org/

Vermont Agency of Natural Resources: http://www.anr.state.vt.us/dec/wastediv/R3/recycle.htm

CHPS Best Practices Manual, vol. 4, Guideline ED3, Recycling: http://www.chps.net/

X. Landscaping to Reduce "Heat Island Effect"

CHPS Best Practices Manual, vol. 2, Guideline GC4: http://www.chps.net/

US EPA, Heat Island Effect: http://www.epa.gov/heatisld/