Maintenance and operations (M&O) of public schools represents a major part of the total lifetime building cost (Figure 1). Assigning energy efficient M&O as a high priority during the initial design phase as well as during the occupied life of a school is cost effective. Our observations indicate a continuing pressure to maintain relatively constant M&O budgets in spite of continuing energy cost increases. Energy costs have increased at a rate greater than total M&O budgets, thereby leaving fewer dollars for M&O as well as other necessary school maintenance and operations. Evaluations of school buildings in more than 100 Texas public school districts. The most commonly observed problems in maintaining and operating public schools for energy efficiency are presented along with successful basic methods of inspecting schools for energy efficient maintenance and operations techniques. Maintenance and operations (M&O) of public schools represents a major part of the total lifetime building cost (Figure 1). Assigning energy efficient M&O as a high priority during the initial design phase as well as during the occupied life of a school is cost effective. Our observations indicate a continuing pressure to maintain relatively constant M&O budgets in spite of continuing energy cost increases. Energy costs have increased at a rate greater than total M&O budgets, thereby leaving fewer dollars for M&O as well as other necessary school maintenance and operations. Evaluations of school buildings in more than 100 Texas public school districts. The most commonly observed problems in maintaining and operating public schools for energy efficiency are presented along with successful basic methods of inspecting schools for energy efficient maintenance and operations techniques. Maintenance and operations (M&O) of public schools represents a major part of the total lifetime building cost (Figure 1). Assigning energy efficient M&O as a high priority during the initial design phase as well as during the occupied life of a school is cost effective. Our observations indicate a continuing pressure to maintain relatively constant M&O budgets in spite of continuing energy cost increases. Energy costs have increased at a rate greater than total M&O budgets, thereby leaving fewer dollars for M&O as well as other necessary school maintenance and operations. Evaluations of school buildings in more than 100 Texas public school districts. The most commonly observed problems in maintaining and operating public schools for energy efficiency are presented along with successful basic methods of inspecting schools for energy efficient maintenance and operations techniques. Maintenance and operations (M&O) of public schools represents a major part of the total lifetime building cost (Figure 1). Assigning energy efficient M&O as a high priority during the initial design phase as well as during the occupied life of a school is cost effective. Our observations indicate a continuing pressure to maintain relatively constant M&O budgets in spite of continuing energy cost increases. Energy costs have increased at a rate greater than total M&O budgets, thereby leaving fewer dollars for M&O as well as other necessary school maintenance and operations. Evaluations of school buildings in more than 100 Texas public school districts. The most commonly observed problems in maintaining and operating public schools for energy efficiency are presented along with successful basic methods of inspecting schools for energy efficient maintenance and operations techniques. Maintenance and operations (M&O) of public schools represents a major part of the total lifetime building cost (Figure 1). Assigning energy efficient M&O as a high priority during the initial design phase as well as during the occupied life of a school is cost effective. Our observations indicate a continuing pressure to maintain relatively constant M&O budgets in spite of continuing energy cost increases. Energy costs have increased at a rate greater than total M&O budgets, thereby leaving fewer dollars for M&O as well as other necessary school maintenance and operations. Evaluations of school buildings in more than 100 Texas public school districts. The most commonly observed problems in maintaining and operating public schools for energy efficiency are presented along with successful basic methods of inspecting schools for energy efficient maintenance and operations techniques.
is based on our on-site evaluations of schools in more than 100 Texas public school districts. The on-site inspections and evaluations include the following M&O items.

- Review utility bills
- Define building energy performance
- Conduct detailed on-site inspection of building and systems (functional, physical, and operational)
- Identify low cost/no cost M&O items to use energy more efficiently
- Review findings with school Superintendent and/or Energy Manager
- Accurately analyses of M&O items identified to define energy savings and estimated cost to implement
- Prepare formal written report for the school

The most common cost effective M&O items are:

1. Summer shut-down of unnecessary equipment (HVAC systems, lights, water coolers, pilot lights, kitchen equipment, etc.).
2. Turn off lights in unoccupied areas.
3. Turn off exterior lights at daytime (manual operation; photocell control, or time clock). Reset time clock for exterior lighting for minimum allowable operation.
4. Turn off kitchen exhaust hood when cooking is complete.
5. Turn off water heaters and circulating pumps when unoccupied.
6. Program existing microprocessor to include school holidays.
7. Turn off HVAC system components (air handlers, boilers, pumps, chillers, cooling towers, etc.) when unoccupied.
8. Adjust exterior door closures for proper closing.
9. Adjust thermostats to recommended settings.
10. Reduce domestic hot water temperature.
11. Reset existing HVAC time clocks (or microprocessor) to achieve minimum daily operating hours.
12. Clean and adjust furnace and boiler burners and heat exchangers.
13. Disconnect fluorescent fixture ballasts where fluorescent lamps have been removed.
15. Clean HVAC coils (condenser and evaporator).
17. Straighten condenser fins.
18. Repair compressed air leaks in ducting and platform plenums.
19. Repair HVAC supply air leaks in ducting.
20. Adjust and weatherstrip exterior doors and windows.
21. Repair HVAC supply air leaks in ducting and platform plenums.
22. Repair compressed air leaks in shop.
23. Turn off air compressor when not in use. Service air compressor and dryer for pneumatic HVAC control system.
24. Replace existing incandescent and quartz exterior lighting with high pressure sodium fixtures.
25. Disconnect football field meter when not needed.
26. Replace incandescent lighting with fluorescent.
27. Install reduced voltage fluorescent lamps and ballasts on maintenance replacement basis.
28. Insulate hot water and steam lines.
29. Repair kitchen freestander and cooler door seals.
30. Repair hot water plumbing leaks.
31. Utilize daylighting by turning off lights.
32. Eliminate any heating and cooling at same time.
33. Install backdraft dampers on all exhaust fans.
34. Instruct kitchen personnel to operate kitchen equipment in most efficient manner.

One of the most commonly observed M&O items is the summer shut-down of unnecessary equipment. As a general rule this results in the most significant savings and requires only a small cost to implement. In fact, many schools have been observed to operate the HVAC system for an entire summer even though no classes are scheduled. In all of the cases observed, a reduction of HVAC and lighting in the summer could save a significant amount of both energy and dollars even if summer office work and/or summer school is held. For example, in order to decrease HVAC equipment
will be more demand based. Installed cost of these systems should cost no more than $7,500 to $12,000.

Another wide variation in Texas public schools is HVAC personnel. Some districts have too many HVAC personnel, and have very organized programs. Unfortunately, many districts do not place a high priority on maintenance. Budget constraints and lack of trained personnel keep some highly skilled Maintenance directors reacting to crises rather than establishing an aggressive preventive and planned maintenance program. A problem common to many districts is that once a maintenance person has been trained and obtains valuable experience the person moves on to other non-school, higher paying jobs. Competitive salaries for good maintenance personnel are a wise investment for schools.

Energy management control systems (EMCS) are becoming increasingly popular to control the operation of air conditioning systems. Maintenance directors and school administrators are faced with proposals with a variety of claims and costs. Considering factors (e.g. cost, benefits, personnel, maintainability, reliability, etc.) the following types of EMCS’s are recommended and have been observed to provide the most overall benefits.

- Mechanical Time Clock
- Electronic Time Clock
- Mid-Range Microprocessor EMCS
- Mid-Range Microprocessor EMCS
- Large-Range Microprocessor EMCS
- Large-Range Microprocessor EMCS

Hard wired systems are recommended for all of the above EMCS systems. For typical schools that have heating and cooling, the mid-range microprocessor EMCS with demand control is recommended. It is anticipated that future electric rate structures will be more demand based. Installed cost of these types of systems for schools range from $7,500 to $12,000. We have observed astronomical prices for EMCS. Prices observed have ranged from $40,000 to $200,000 for a single school.

Typical Elementary and Junior High EMCS systems should cost no more than $7,500 to $12,000 installed. For schools with up to approximately 150 students, the systems installed should cost no more than approximately $7,500, and for schools with 600 students the cost should not exceed approximately $12,000. Larger schools with up to 1,500 students may range up to $20,000. Any installed cost exceeding $20,000 for any EMCS should be reviewed with care by a Professional Engineer. All EMCS systems should be specified by an independent consultant with no financial interest in the hardware or installation. We have observed many schools where the equivalent systems could have been purchased for a fraction of the cost.

CONCLUSIONS

The following conclusions/recommendations are based on our observations of maintenance and operations of Texas public schools:

1. Significant savings in energy and dollars can be achieved in almost all schools through a better EMCS program.
2. Many schools do not monitor energy performance or compare costs in a meaningful manner. All schools should monitor energy costs and usage on a monthly basis and be alert for opportunities to save both energy and dollars.
3. Annual rate structure analyses and evaluation of utility bills should be accomplished. Call the local utility or an independent consultant for assistance. Obtain training to accomplish in-house analyses.
4. At a minimum, annual energy conservation and maintenance inspections should be accomplished for every building.
5. Retention of good maintenance personnel is a problem in many school districts.
6. There is a continuing need for training of school energy managers, maintenance directors, maintenance personnel, and school administrators.
7. Cost/No cost energy conservation programs (such as those offered by the Public Utility Commission of Texas) can be of highly significant value in the overall EMCS plan for a school district.

REFERENCES

LONG TERM ALTERATIONS

MAINTENANCE/OPERATION 50%

FIRST COST 11%

LONG TERM FINANCING 10%

ALTERATIONS 23%

LIFETIME BUILDING COSTS

FIGURE 1 (1)

TOTAL OM BUDGET

ENERGY COSTS

DOLLARS FOR MAINTENANCE

DOLLARS FOR ENERGY

YEARS →

FIGURE 2 (1)

EXISTING TEXAS SCHOOLS

Figure 3

Proceedings of the Third Symposium on Improving Building Systems in Hot and Humid Climates, Arlington, TX, November 18-19, 1986
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Figure 4

ENERGY USE AND COST
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