Alaska School Facilities Preventive Maintenance Handbook

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Education Support Services / Facilities

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Overview

The goal of preventive maintenance, as a component of a facilities maintenance system, is to maximize the useful life of all building systems. Just as maintenance is an aspect of facility management that impacts most other areas of the total facility operation, so to preventive maintenance, as a philosophy, has a broad influence on the total maintenance effort. At its heart, preventive maintenance asks, "What can I do to make this item—be it an automobile, building, or piece of equipment—remain as good as new for as long as practicable?"

Many discussions of maintenance relegate preventive maintenance to a small role, for example:

> "Preventive maintenance (PM) is defined in the maintenance management audit as periodically scheduled work on selected equipment, usually dynamic, to provide for required inspection, lubrication and adjustment."[1]

However, a broader application of the term 'preventive maintenance' is desirable to avoid fragmentation of the maintenance system into multiple subcomponents where routine, preventive, regular, scheduled, recurring and other variations of maintenance each have their own definition. For the purposes of meeting the requirements and intent of Alaska Statutes, the Department of Education & Early Development (EED) encourages a vision of preventive maintenance as all activities that can be **regularly scheduled** to prevent premature failure or to maximize the useful life of a facility. Preventive maintenance applies to all building systems and components. Scheduled activities will include items such as roof inspections, repainting, and door hardware adjustments, as well as more traditional items such as bearing lubrication and belt replacements on HVAC equipment.

It is essential that school boards and school district administrators and staff demonstrate a commitment to this vision—scheduled maintenance on the full range of building systems—when acting on their responsibility to manage district facility assets. To meet the duties of school boards specified in statute, preventive maintenance should be a key element of a school board's mission statement.

Alaska Statutes

Alaska statutes:

- Assign responsibility for preventive maintenance, custodial services and routine maintenance (AS14.14.090, AS 14.08.111, AS 14.14.060)

> AS 14.14.090: *In addition to other duties, a school board shall . . .*
> *(10) provide for the development and implementation of a preventive maintenance program for school facilities . . .*

AS 14.08.111: *A regional school board shall . . .*
(8) provide custodial services and routine maintenance of school buildings and facilities;

AS 14.14.060
(f) The borough school board shall provide custodial services and routine maintenance for school buildings and shall appoint, compensate and otherwise control personnel for these purposes. The borough assembly through the borough administrator, shall provide for all major rehabilitation, all construction and major repair of school buildings. The recommendations of the school board shall be considered in carrying out the provisions of this section.

- Define preventive maintenance (AS 14.14.090); and,

AS 14.14.090
(10) . . . in this paragraph, "preventive maintenance" means scheduled maintenance actions that prevent the premature failure or extend the useful life of a facility, or a facility's systems and components, and that are cost-effective on a life-cycle basis.

- Establish the requirements of a preventive maintenance plan (AS 14.11.011).

AS 14.11.011: *(b) For a municipality that is a school district or a regional educational attendance area to be eligible for a grant under this chapter, the district shall submit . . .*
(4) evidence acceptable to the department that the district
(A) has a preventive maintenance plan that
(i) includes a computerized maintenance management program, cardex system, or other formal systematic means of tracking the timing and costs associated with planned and completed maintenance activities, including scheduled preventive maintenance;
(ii) addresses energy management for buildings owned or operated by the district;
(iii) includes a regular custodial care program for buildings owned or operated by the district;
(iv) includes preventive maintenance training for facility managers and maintenance employees;
(v) includes renewal and replacement schedules for electrical, mechanical, structural, and other components of facilities owned or operated by the district; and
(B) is adequately adhering to the preventive maintenance plan.

Read in their entirety, these statutes establish that preventive maintenance of Alaska schools is solely the responsibility of school districts and that funding for such must be included within the district's operating budget. Some school districts share the duties of maintenance with another agency within the city or borough. The statutes in no way prohibit districts from acting in conjunction with these associated agencies to effect all or a part of their maintenance program. However, doing so does not relieve the school board of its obligations in the areas of preventive maintenance.

Also, based on this statutory authority, the department's capital improvement project (CIP) application does not allow capital funding for the accomplishment of preventive maintenance nor for projects caused by lack of it. A district requesting capital funding from either the school construction fund or major maintenance fund must provide "evidence that the project should be a capital improvement project and not part of a preventive maintenance program, or regular custodial care."

Developing a Preventive Maintenance Program

Introduction

By law, school districts have two main responsibilities regarding preventive maintenance. The first of these responsibilities is to *develop* a preventive maintenance program, the second is to *implement* the program. This section offers guidance in developing an effective preventive maintenance program.

Preventive maintenance has to be intentional. The Encyclopedia of Architecture states, "Preventive maintenance programs should not be thought of as spontaneous natural events that will occur in the passage of time to meet the needs of the systems in place. Preventive maintenance programs begin with the acceptance of a need and the development of a considered, planned program for addressing the individual and different needs of each specific unit or system in a project."[2]

Many districts have already developed a traditional preventive maintenance program for various types of mechanical and some electrical equipment and components. Industry leaders in the design and manufacture of this type of equipment have long advocated for and effectively promoted maintenance of their equipment. In the early stages, this effort consisted of operations and maintenance manuals. While these are still in use, advanced microprocessor-based diagnostic and control systems have supplemented their use.

In extending the scope of preventive maintenance to maintenance work on any building system or component that can be regularly scheduled, each district will be required to

reassess their program's breadth and enhance it as necessary. The first step in this process is to identify the facilities that require preventive maintenance and their particular building systems and components that will respond effectively to preventive maintenance. The next step is to determine the present condition, establish a level of maintenance and write preventive maintenance tasks for each system or component.

Identification of Systems and Components

The department has established a baseline for a comprehensive preventive maintenance program by identifying facility systems and components that should be included in such a program. A list of the components can be found in Appendix A. While thorough, the list is not intended to be an exhaustive list of every component. From the list, select those systems and components that apply to each of the district's facilities. Districts may add items if necessary to create a complete plan.. Many buildings will have multiple system types within a particular category (e.g., roofing, package unit heaters, etc.) as well as multiple components of the same type (e.g., circulating pumps, water closets, toilet partitions, etc.). For each item, a specific preventive maintenance plan will need to be developed. The greater the number of differing systems and components, the greater effort will be necessary in both developing and implementing the preventive maintenance plan. Standardizing systems and components within a district offers measurable benefits to a district preventive maintenance plan. These benefits include reductions in inventory, reductions in preventive maintenance training and increases in productivity and quality of work.

The Appendix A list of systems and components is designed to dovetail with other facility assessment devices such as the CEFPI *Alaska School Facility Appraisal* and the EDD *Guide for School Facility Condition Survey*, as well as facilities audits outlined by literature from the Association of Physical Plant Adminstrators (APPA).

Determining Present Conditions

Following the identification of systems and components in each facility, a detailed inventory is needed to quantify the building components and to establish their current condition. This step includes both an objective process of fact-gathering and a subjective assessment of the current condition. Information such as quantity, type, size, manufacturer, model, material specification, location, key parts, part numbers, and other item-specific data will be documented. A qualified technician or professional will need to make the assessment of current condition. The condition assessment is used to determine both the immediate and future levels of preventive maintenance for the system or component and its end-of-service-life replacement date.

Establishing Levels of Maintenance

Preventive maintenance efforts range from visual inspections only to performance testing and analysis; from minor adjustment, cleaning and/or lubrication to complete overhauls; from reconditioning to components replacement. [3]

School districts that are accredited by the Northwest Association of Schools and Colleges will recall that the accreditation standards include the following:

> Standard III - School Plant and Equipment
> "13. Inspection(s) of the school plant and equipment **shall** be made each school year by a qualified official and any deficiencies addressed." [4]

This type of standard is an example of a preventive maintenance requirement at the visual inspection level.

In establishing levels of maintenance, two determinations are needed. The first is to establish a basic life-span for the system or component (e.g., asphalt shingle roofing - 20yrs, oil-fired boiler, 15yrs, drive belt – 3yrs, etc.). The second determination is, "What maintenance activities are needed to ensure that this particular system/component meets or exceeds its life expectancy?"

Manufacturer's literature, experience, test results, and industry averages are some ways to determine both acceptable life-cycles and what preventive maintenance work would result in achieving those life expectancies in the most efficient manner (i.e. the lowest life-cycle cost).

Preparing the Work Items Plan

Once your levels of maintenance have been established, setting the tasks into a workplan is the next step. According to Basil Castaldi, a recognized expert in the field of facility planning and author, four elements make up any preventive maintenance work item.

> "In any prescribed maintenance program, the list of tasks to be performed is described in detail. The frequency and nature of the work are clearly stated. The materials to be used are specified in considerable depth and the manner in which the work is to be accomplished is expressed in simple language." [5]

Implementing a Preventive Maintenance Program

Introduction

Where the first school board responsibility was to *develop* a preventive maintenance program, the second responsibility is to *implement* a preventive maintenance program. This section offers guidance on carrying out the developed preventive maintenance work plan and establishes the importance of having management reports and a system of feedback from the field in order to implement an effective program.

The basic task of preventive maintenance implementation is to match needs with resources. However, both needs and resources are variables in the facilities management effort. As a result, implementation efforts may occur once to initiate a preventive maintenance program but will also require continuous monitoring of needs and resources to accommodate changes in these variables. For example, the work items assessment of a circulating pump may have indicated an anticipated failure in three years. At the three-year point, a stress test of the pump may indicate no appreciable degradation has occurred. This information may necessitate a revision to the preventive maintenance plan initially implemented. Other examples include the impact of new technologies, improvements to building systems or new tools that reduce repair times. These examples of variables in needs and resources all support the conclusion that implementation requires both an initial and an on-going effort.

Moving from the planning and development phase to implementation and operation almost always involves funding, regardless of the endeavor. Preventive maintenance is no exception. As evidence of the importance of funding in this transition, the portion of the Encyclopedia of Architecture devoted to implementation of a preventive maintenance program is largely a discussion of funding. [6] Because funding is so critical to the transition, some findings from research concerning maintenance funding and resources are included in the following paragraphs.

Determining Necessary Resources

As previously mentioned, most of the resource requirements result in a need for funds. Determining the level of funding needed for preventive maintenance at a detailed level requires estimating literally thousands of labor and material line items. This method is very time consuming. Other approaches to budgeting for preventive maintenance include establishing a formula based on a percentage of the operating budget or a percentage of building replacement value(s). In California, research showed that:

> "If a planned maintenance program is followed, about 5 percent of a district's operating budget will be required to provide an adequate maintenance program.

> In addition to the 5 percent expenditure for the district's maintenance program, a reserve fund is needed for unanticipated and emergency maintenance expenditures. Another criterion for determining budget requirements is to calculate 2.9 percent of the current net building replacement cost or a projected cost based on the square footage of property to be maintained." [7]

In another budgeting formula, the Encyclopedia of Architecture indicated:

> "The cost of preventive maintenance ranges according to the intent of the *plans developed.* To set a budget for this type of work, one may estimate 5% of the present value of the building for preventive maintenance activity. Perhaps 1.5% of the value of the building may be estimated for simpler structures or systems." [8]

The department's capital improvement project (CIP) application scoring criteria assigns increased points to districts based on the percentage of total maintenance expenditures relative to the building replacement value(s). Maximum points are achieved when the percentage is 5% or greater.

One effective strategy for determining the necessary resources is to identify the smallest detailed increments of the preventive maintenance plan and combine them for the aggregate picture. Take each well developed preventive maintenance work item and ask, "What skills (trained personnel), tools, materials (parts etc.), and time are needed to complete this work item?" Once these factors are tabulated and the resource needs are clear, the supporting issues of space for shops, material staging and transportation requirements can be addressed.

While starting with the most detailed information and building up yields a comprehensive assessment of necessary resources, broad and systematic thinking is required to arrive at the necessary organizational structure with which to accomplish the preventive maintenance program.

Determining Organizational Structure

The structure and organization of the preventive maintenance program must be in place before effective scheduling of work can occur. Some operations and maintenance organizations establish a cross-disciplined preventive maintenance work center whose main task is to inspect various systems and components (usually dynamic equipment) and write maintenance work orders. Following the inspection, more traditional work centers such as plumbing, sheet metal, etc. are assigned the actual work tasks. Other maintenance organizations are oriented almost completely to preventive maintenance tasks with major crafts taking responsibility for components and systems within their respective areas. In this model, a small multi-disciplined workcenter handles routine maintenance and emergency repairs and, in some cases, minor improvement work.

Rural school districts have their own unique challenges in establishing an organizational structure for preventive maintenance efforts. The availability of trained workers, limited accessibility, and logistical concerns are among the factors that will influence the organization. A common structure for many rural districts is to have one or two on-site custodial and general maintenance personnel supplemented by a traveling team of maintenance personnel with journeyman skills in the various building trades.

These are just some of many options available in establishing a structure for preventive maintenance scheduling.

Scheduling and Assigning Work

The heart of any preventive maintenance program is scheduling and assigning specific preventive maintenance tasks. This is almost always done on a work order system. This element of the preventive maintenance program takes the work items developed for each component and assigns them to the appropriate maintenance craftsperson or team according to the established structure and schedule.

Simple preventive maintenance programs can be executed using a manual system of scheduling and work tracking. The statutory language in AS14.11.011 refers to this method as a "cardex system." One writer describes an approach to such a method as follows:

> "He or she may wish to record each task to be performed on a card. This may include a description of the task and the tools and the materials to be used. These cards may well serve as a 'tickler file' or a reminder to the *maintenance manager* as to when the task should be completed. He or she should note on the card the date of the next time when the work is required and file all of the cards chronologically by date, starting with the current date. In this way, the *maintenance manager* will know at a glance what needs to be completed within a given month, week or day. Once the work is completed, he or she can record what was done on the back of the card." [9]

Although preventive maintenance tasks can be managed using a manual system, the computerized maintenance management system is now state-of-the-art and financially affordable for even the smallest maintenance organizations. In many school districts, maintenance managers are running computerized maintenance management programs particularly suited to preventive maintenance. Once pertinent data is entered into the database system, work orders detailing the preventive maintenance requirements can be generated and tracked. More advanced programs have an integral query feature which prompts maintenance managers for necessary input and provides industry standards for certain maintenance tasks. It is estimated that there are more than fifty (50) suppliers of maintenance software packages with price variations based on need and capacity. Maintenance magazines and the world-wide-web are good locations to look for these products.

Reporting Systems and Feedback

In addition to automating the list of items needing preventive maintenance at specified times, most maintenance management software programs also provide the capability for a computerized building data file. This database of facility requirements can be used to generate a wide variety of accurate reports on matters related to building maintenance and operations and their associated costs. To a certain extent, an integrated maintenance system that incorporates both daily maintenance tasks and long range planning depends on an automated database of facility information. Effective preventive maintenance programs depend on feedback from maintenance personnel and a reporting/tracking system of costs associated with the preventive maintenance effort. This information is used to maintain the proper balance between preventive maintenance and renewal and replacement efforts (i.e., determining when have costs increased to the extent that preventive maintenance on a system is no longer effective on life-cycle basis).

Through a combination of informal evaluations and formal audits, a reporting system should be established to analyze a district's maintenance system to achieve the most cost-effective maintenance program. In addition to general feedback and reporting, district maintenance programs should undergo periodic evaluations of their effectiveness. This can occur both at the worker's task level and at the maintenance management level. Evaluations can be done either internally or through the use of an outside evaluation team. Maintenance management audits examine the functional program and generally consider the following four factors:

Productivity - the portion of a worker's time that is directly productive.
Performance - how well the individual is working, i.e., is work being completed as planned?
Work Quality - are they producing a satisfactory work product.
Priority - effective allocation of available time to the most important tasks. [10]

Though maintenance management audits may look at symptoms of ineffective maintenance at the worker/task level (i.e. number of callbacks, work completed on schedule, etc.), a management audit's focus, as the name implies, is on improvements through better management.

Conclusion

It is imperative that school districts in Alaska perform preventive maintenance on their facilities. Inadequate preventive maintenance not only hastens the deterioration of district assets, it jeopardizes the district's ability to qualify for state aid for school capital projects. This handbook has provided a scope for preventive maintenance efforts (ref. Appendix A). It has also identified statutory responsibilities and established a framework for developing and implementing a preventive maintenance program.

Notes

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2. **Encyclopedia of Architecture**, John Wiley and Sons, Inc. p.68

3. Applied Management Engineering, PC, Kaiser, Harvey H.; **Maintenance Management Audit: A Step By Step Workbook to Better Your Facility's Bottom Line**; Kingston, MA; R.S. Means Company, Inc., 1991. p.83

4. **Standards for Accreditation**; Northwest Association Schools and Colleges, 1995, p. 11

5. Castaldi, Basil; **Educational Facilities: Planning, Modernization, and Management**; Allyn and Bacon, 1982, rev. 1994, p. 421

6. **Encyclopedia of Architecture**, John Wiley and Sons, Inc. p.70

7. School Facilities and Transportation Division; **Administration of Maintenance and Operations in California School Districts: A Handbook for School Administrators and Governing Boards**; California State Department of Education, 1986, p. 33

8. **Encyclopedia of Architecture**, John Wiley and Sons, Inc. p.70

9. Castaldi, Basil; **Educational Facilities: Planning, Modernization, and Management**; Allyn and Bacon, 1982, rev. 1994, p. 420

10. Applied Management Engineering, PC, Kaiser, Harvey H.; **Maintenance Management Audit: A Step By Step Workbook to Better Your Facility's Bottom Line**; Kingston, MA; R.S. Means Company, Inc., 1991. p.9-10

Appendix A
Sample Systems and Components Inventory List

Foundation and Substructure

- Footings
- Foundation walls
- Slab/beams on grade
- Piling/Posts
  - thermopiles
- Reinforcing
- Connectors
- Waterproofing
- Insulation
- Underdrains

Superstructure

- Columns
- Beams
- Rigid frames
- Floor structure
  - joists
  - deck/slab/sheathing
  - ramps
- Roof structure
  - trusses
  - deck/slab/sheathing
- Monolithic bearing walls
- Stairs and railings
- Structural bracing
- Welds/connectors

Exterior Wall Systems

- Wall construction
- Cladding/sheathing
- Doors
  - frame
  - door unit
  - hardware
- Glazing systems
  - frame
  - glazing
  - hardware
  - curtain walls
  - storefronts
- Balcony walls/railings
- Louvers and screens
- Expansion/seismic joints
- Insulation
- Protective coating
- Sealants

Appendix A
Sample Systems and Components Inventory (cont.)

Roof Systems

- Roofing
- Insulation
- Paving and ballast
- Curbs/supports
- Expansion/seismic joints
- Drains, gutters and d.s.
- Drywells
- Flashing and trim
- Fasteners
- Snow stops
- Roof openings

Interior Construction

- Fixed partitions
- Demountable partitions
- Retractable partitions
- Doors
  - frame
  - door unit
  - hardware
- Glazing systems
  - frame
  - glazing
  - storefronts/entrances
- Interior finishes
  - carpet
  - resilient tile/sheet
  - ceramic/clay tile
  - terrazzo
  - paint
  - vinyl/fabric wall cover
  - wood
  - metal panels
- Ceiling system
  - suspension grid
  - acoustical units
  - soffits (metal/gyp.)

Specialties

- Toilet partitions
- Display boards
- Projection screens
- Display cases
- Lockers
- Flag poles

Appendix A
Sample Systems and Components Inventory (cont.)

Conveying Systems
- Elevators
- Moving stairs/walks
- Dumbwaiters
- Pneumatic tube
- Lifts(material/personnel)

Heating Systems
- Boilers
- Furnaces
- Burners
- Fuel tanks & distribution
- Heat transfer equipment
  - heat exchangers
  - coils
- Terminal/package units
- Fin tubes/radiators
- Heating accessories
  - dampers/draft control
  - breeching and ductwork
  - stacks
  - insulation
  - piping
  - valves

Air Handling Systems
- Air handling units
- Unit ventilators
- Fans
- Inlets/outlets
- Ducting systems
  - dampers
  - filters
  - mixing boxes
  - sound attenuators
- Humidifiers
- Dust collection systems

Cooling Systems
- Condensing units
- Compressors
- Heat exchangers
- Packaged A/C units
- Chillers
- Absorption units

Mechanical Controls
- Compressors

Appendix A
Sample Systems and Components Inventory (cont.)

- Pneumatic valves/levers
- Pneumatic tubing
- Electronic controls

Plumbing Systems
- Cold water piping
- Water heater
- Hot water piping
- Pumps
  - sewage lift
  - water booster
  - circulating
  - sump
- Valves and traps
- Insulation
- Plumbing fixtures
  - sinks and faucets
  - toilets/urinals
  - coolers/drinking fountains
  - exterior hose bibs
- Waste vents
- Waste piping
- Septic tanks

Fire Protection/Suppression Systems
- Sprinkler piping
- Backflow preventers
- Sprinkler heads
- Fire extinguishers
- Fire hose system
- Standpipe connection
- Fire pumps
- Grease hood extinguisher

Power Generation and Transmission
- Generators
- Engines/turbines
- Transfer switches
- Transformers
- Service wiring
- Substation
- Switchgear
- Bus ducting
- Overcurrent protection

Appendix A
Sample Systems and Components Inventory (cont.)

Power Distribution Systems
- Main distribution panel
- Wiring
- Conduits
- Raceway

- Cable trays
- Distribution panels
- Electrical receptacles
- Circuit breakers
- Baseboard heaters
- Motors/fans
- Heat trace

Lighting Systems
- Fixtures
  - fluorescent fixtures
  - incandescent fixtures
  - HID fixtures
- Wiring
- Lighting panels
- Emergency lighting
- Standby lighting
- Exterior lighting

Signal Systems
- Computer data
- Public address
- Television
- Telephone
- Clock system
- Satellite delivery system
- Fire alarms
- Fire door hold-opens
- Security alarm/devices

Landscaping Systems
- Irrigation
- Tree/shrub plantings
- Flower bed plantings
- Turf/lawn
- Walks/plazas

Appendix A
Sample Systems and Components Inventory (cont.)

Playfields and Playground Systems
- Football fields
- Baseball/softball fields
- Hard surface courts
- Hockey/skating rinks
- Playdecks
- Swings
- Climbing toys
- Safety mats
- Gravel and containment
- Markings/painting

Vehicular Systems
- Parking lots
- Roads/drives
- Curbs
- Fire lanes

Site Utilities
- Fuel tanks
- Fuel distribution piping
- Storm drainage
- Fire hydrant systems
- Electrical power
- Pole-mounted lighting

Equipment
- Furnishings
  - classroom furniture
  - seating
  - rugs and mats
- Fixtures
  - window treatments
  - artwork
  - vending
- Equipment
  - waste handling
  - loading dock
  - parking equipment
  - postal
  - food service
  - woodworking shop
  - auto/engine shop
- Special construction
  - vaults
  - swimming pools
  - acoustical enclosures
  - raised computer flooring

Appendix B
Definitions

Component

A part of a system in the school facility.

Component Repair or Replacement

The unscheduled repair or replacement of faulty components, materials, or products caused by factors beyond the control of maintenance personnel.

Custodial Care

The day to day and periodic cleaning, painting, and replacement of disposable supplies to maintain the facility in safe, clean and orderly condition.

Deferred Maintenance

Custodial care, routine maintenance, or preventive maintenance that is postponed for lack of funds, resources, or other reasons.

Major Maintenance

Facility renewal that requires major repair or rehabilitation to protect the structure and correct building code deficiencies, and shall exceed $25,000 per project, per site. It must be demonstrated, using evidence acceptable to the department that (1) the district has adhered to its regular preventive, routine and/or custodial maintenance schedule for the identified project request, and (2) preventive maintenance is no longer cost effective.

Preventive Maintenance

The regularly scheduled activities that carry out the diagnostic and corrective actions necessary to prevent premature failure or maximize or extend the useful life of a facility and/or its components. It involves a planned and implemented program of inspection, servicing, testing and replacement of systems and components that is cost effective on a life-cycle basis.

Renewal or Replacement

A scheduled and anticipated systematic upgrading of a facility system or component to rehabilitate it to a renewed functioning standard.

System(s)

An assembly of components created to perform specific functions in a school facility, such as a roof system, mechanical system or electrical system.

Note: The above definitions are those adopted by the Bond Reimbursement and Grant Review Committee 4-18-97.