July 8, 1993
ILR 93-J

Senator Eldon A. Money
Utah State Senate
State Capitol
Salt Lake City, Utah 84114

Subject: School Building-Equipment Maintenance in Jordan, Alpine, and Granite Districts

Dear Senator Money:

This report responds to your request for a review of the Jordan School District's building-equipment maintenance program, with particular emphasis on preventive maintenance. A similar-sized district (Granite) and a smaller one (Alpine) were added for perspective. Although none of the three districts has a formal, comprehensive preventive maintenance (PM) program, we believe such programs could save expensive equipment repairs and replacements. Alpine and Granite Districts operate some limited PM programs for specific types of equipment, which appear to reduce expensive repairs and replacements for those types of equipment. Districts should judiciously set up PM programs (including custodial participation), beginning with their more expensive equipment.

Preventive maintenance is the periodic servicing of equipment to avoid facility downtime and to reduce expensive repairs and replacements. Since no district reported any school days lost because of building equipment failure, the study's emphasis was on reducing expensive repairs and replacements. Only expensive building equipment, such as heating, ventilation, and air conditioning (HVAC) and electrical were considered. In this report, a formal PM program includes scheduling, assigning, and reporting of the PM work .

Preventive Maintenance Could Save Expensive Repairs and Replacements

Preventive maintenance could reduce expensive equipment repairs and replacements. To be effective, PM servicing must be scheduled and assigned at appropriate intervals and

reported when completed. Also, the maintenance department needs to know what PM servicing is being done by the custodians.

Both custodians and maintenance workers can perform PM work, but it should be coordinated by scheduling, assigning, and reporting the work. Custodians should do the routine inspection and servicing of equipment. For example, custodians should change air filters, which maintains equipment efficiency and helps prevent damage. They could lubricate motors and pumps, which usually saves having to rebuild them. Most important, they should promptly report equipment leaks and unusual noises to enable timely and less expensive repairs. Maintenance workers should do the more technical servicing and minor repair work that extends the life of the equipment. For example, maintenance workers should replace leaking pump seals to avoid rebuilding of the pump and service electrical panels to prevent loss of the entire panel. They should test and adjust boiler controls to maximize efficient use of fuel and adjust air handling fan controls to prevent destruction of the fan units. At the completion of the work, both custodians and maintenance workers need to report its completion so that the district can know which equipment has been serviced and which has not.

The following are examples of recent equipment breakdowns because of inadequate PM servicing in the three districts. The examples generally are from the past year, although some repeat examples are from two or three years ago. Because the information sources were limited, the examples are not inclusive and may represent only a small part of such equipment failures.

Jordan District Has No Formal PM Experience

The Jordan District has no experience in formally scheduling and assigning PM work to custodians and maintenance workers and having them report its completion. Jordan District maintenance workers may occasionally do PM work on their own initiative, but they typically do not report it. Custodians are supposed to do PM work, but it is not scheduled or assigned, nor is it specifically reported. Thus the district does not know which equipment receives PM services and which does not, nor does the maintenance department know what PM work is being performed by custodians. The director of maintenance believes many custodians fail to do PM work because several schools have much higher maintenance repair costs than others of the same size.

Figure I lists some examples of expensive equipment that had to be repaired or replaced; maintenance workers and their director said these were due to lack of preventive maintenance.

Figure I
Jordan School District
Examples of Repairs and Replacements Because of Lack of PM

School	Equipment	Problem and Cause	Cost
A	Variable Pitch Fan	Destroyed by vibration; damper controls not serviced	$9,667
B	Air Cond Chiller	Chiller coils frozen and destroyed; not drained for winter	9,000

B	Air Cond Chiller	Same chiller coils frozen again the following year and destroyed; not drained for winter	9,000
C	Roof-top Heater	Fan bearings and shaft destroyed; not lubricated	1,800
D	Swimming Pool	Suspended 6-inch water line dropped, flooding tunnel and boiler room; rusted pipe hangers not replaced	11,400
E	Hot water System	Rebuild 6-inch circulation pump; not lubricated	2,900

Jordan District officials told us they are committed to preventive maintenance and are planning to set up a formal, comprehensive scheduled, assigned, and reported servicing of their significant building equipment.

Granite District Has Only Limited PM Experience

The Granite District has no formal PM program except for electric motors and air compressors. It had a PM program for its boilers but discontinued it several years ago because of a reduction in staff. Custodian-performed PM work varies greatly. Based on their observation of the equipment, maintenance workers and others told us that some custodians are very good and some very weak in performing PM work. Further, the district has no way of knowing what PM work is being done by custodians because it is not scheduled or reported.

Following are examples of repairs or replacements of equipment, some expensive, which maintenance workers, their director, and others said was caused by lack of PM servicing.

Figure II
Granite School District
Examples of Repairs and Replacements Because of Lack of PM

School	Equipment	Problem and Cause	Cost
A	Variable Pitch Fan	Destroyed by vibration; damper controls not adjusted	$6,110
B	HVAC Controls	Ruined by water in air lines; compressor not drained	1,969
C	Water Heater	Destroyed by corrosion; leak not reported over a year	2,185 *
Many	Lamp Fixtures	One-fourth of ballast replacements could be avoided by replacing blackened tubes	9,134
D	Water Heater	Unit nearly exploded; blow off valve had not been periodically opened, so failed to function	Near-miss liability
E	Condensate Pump	Burned out pump not reported, remaining motor destroyed	439

F	Heat line Pump	Rebuild pump; leak not reported in a timely manner	358
G	Water Cooler	Compressor burned out; lint and dust not cleaned from condenser	108

** Replacement would have cost $13,000; however, elementary students don't shower at school, and thus a smaller replacement heater was adequate.*

During the past year, the Granite District has been developing a pilot PM program in 12 schools for the plumbing trades. Also, in January 1993 the electrical shop began to expand its PM program beyond electric motors.

Alpine District Had a Formal PM Program

Before its old computer system failed, the Alpine District operated a formal PM program for 12 months. During that time, the custodians were trained in PM procedures and apparently most still perform at least some of the PM work. Maintenance personnel estimate that 80 to 90 percent of the custodians are doing PM work such as lubricating motors and pumps, draining water from compressor tanks each week, and changing HVAC filters. In addition, for six years the plumbing shop has operated a partial PM program, particularly for boilers. Also, the district contracts refrigeration and air conditioning PM work.

We were unable to identify any specific, significant equipment failures that could be linked to a lack of PM service. However, the electrical and plumbing leadmen estimated that one-half of the electric motor repairs and one-fourth of the fan and pump repairs could be avoided with a formal PM program. Following are the respective calculations for these equipment categories for the six month's experience available in the computer.

Figure III
Alpine District
Examples of Repairs and Replacements Because of Lack of PM

School	Equipment	Problem and Cause	Cost
Many	Electric Motors	One-half of electric motor repairs could be avoided with PM program, per electrical head	$1,673
Many	Large Fans and Pumps	One-fourth of fan and pump repairs could be avoided with PM program, per plumbing head	2,260

The Alpine District plans to re-implement its formal, comprehensive PM program by the end of this calendar year. It is fortunate to have retained the equipment inventory data and PM procedures from its prior program, thus shortening the anticipated re-implementation time to about six months.

Limited PM Programs Appear to Reduce Expensive Repairs and Replacements

Alpine and Granite Districts' limited PM programs appear to reduce expensive repairs and replacements. A comparison was made among the three districts of the effect of having or not having PM programs for air compressors and boilers. The districts' different reporting systems limited comparisons to these two categories. Although not conclusive, districts having PM programs for specific types of equipment appear to realize reduced repair and replacement costs for the respective equipment types.

In making these comparisons, we did not factor for the many variables such as the average age of the districts' schools, how much equipment had been replaced with new or upgraded equipment, and how many schools each district has. However, the number of schools in the Alpine District is approximately one-half that in either Granite or Jordan Districts.

Lower Air Compressor Repair Costs With PM

Air compressors supply the air necessary to operate HVAC controls such as thermostats. To avoid damage to the controls, water which accumulates from atmospheric moisture when the air is compressed must be drained from the compressor tanks. Also, to avoid having to overhaul or replace compressors, the oil must be checked and added when needed.

For 12 months, the Alpine District operated a formal PM program, involving both custodians and maintenance tradesmen. Detailed instructions and work orders assigned the PM work to each individual, who returned the work order with a notation of the work's completion. Although the program ended when the old computer system failed two years ago, custodians were trained in PM work during that time and appear to be continuing some PM work, at least for air compressors. Also, the district has installed air dryers on the air lines coming from the compressors to further help prevent moisture getting into the air lines. During the five winter months of 1992-93 for which data were available, Alpine District replaced or overhauled no compressors, but the plumbing leadman said the district typically overhauls one per year at a cost of about $450. Further, the district appears to have had no cases of damaged HVAC controls because of water in the air control lines.

For 12 years, the Granite District machine shop has operated a scheduled PM program for the district's air compressors, including thorough annual servicing and periodic checks throughout the year. During the ten month period of July 1992 to April 1993, Granite District overhauled two compressors at a cost of $560 and $580. Although the district earlier experienced some damage to its HVAC controls from water getting into the control lines, it apparently has solved that problem by installing automatic drains and air dryers.

The Jordan District has never had a formal PM effort in any of its equipment categories, nor has it installed automatic drains or air dryers. In contrast to Alpine and Granite Districts' low compressor repair costs, Jordan District had to replace a large compressor unit in 1992 at a cost

of $5,000. That replacement followed a $3,200 overhaul of the previous compressor two years earlier. A similar sequence of replacements occurred at another school where two large compressor units were replaced a couple of years apart at a total cost of $8,000. Maintenance personnel told us the compressors were lost for the lack of checking and adding oil to the compressors. In addition, HVAC controls have had to be replaced at various district schools because water got into the control air lines.

This comparison suggests that Alpine and Granite Districts, with recent or current compressor PM programs, realize cost savings compared with Jordan District which has not had a compressor PM program.

Lower Boiler Repair Costs With PM

We compared the Granite District's boiler repair costs with those of Alpine. Jordan District's heating systems are largely comprised of roof-top units, not boiler systems. Whereas Granite discontinued its boiler PM program several years ago after staffing cuts, Alpine initiated its program. For six years, Alpine's plumbing shop has scheduled plumbers to test boiler controls, clean or replace water level tubes, and periodically test all boilers' water for corrosiveness and add necessary chemicals. The PM work is assigned and reported on maintenance work orders. During the five winter months of 1992-93, Alpine had $16,870 in boiler repairs. As noted on page 6, Alpine has one-half as many schools as Granite.

After terminating its boiler PM program, the Granite District assigned its boiler water testing and chemical addition program to the custodians. Because custodians' PM tasks are not scheduled or assigned and are not reported, the district does not know which boilers are being tested and having chemicals added and which are not. Maintenance personnel told us they can tell that not all boilers are receiving the PM service because of the condition of some boilers. For ten months in 1992-93, Granite district experienced $101,378 in boiler repairs.

To illustrate the seriousness of Granite's lack of a boiler PM program, Granite District has two schools with recurring boiler problems because custodians are not performing their PM duties. According to the maintenance workers and their director, custodians failed to blow down the boilers to remove the sludge, failed to monitor and add chemicals to the boilers' water, and in one case reheated a boiler too rapidly which caused uneven expansion and created leaks. As a result, the district had to repair one boiler twice and the other three times within six months at a total cost of $12,965. Further, an additional repair cost will be incurred this summer when one of the boilers can be shut down for a longer period. In fairness to one custodian, the director of maintenance said leaking steam traps, which are a maintenance staff PM responsibility, caused some of the excessive build up of sludge. Thus, there is also a need for maintenance staff PM to reduce boiler repairs.

The results of this comparison suggest that Alpine District's ongoing PM program for boilers is saving money, while the discontinued PM program in Granite District is causing unnecessary expense. Granite District is beginning to implement a pilot PM program in 12 schools for plumbing. However, the district needs to immediately re-implement an effective PM program for all of its boilers because of their great potential for costly repairs if not properly serviced.

Districts Should Judiciously Set Up Preventive Maintenance Programs

In setting up formal PM programs, districts should begin with equipment areas that have the greatest promise of savings and include custodial participation. While this survey shows that PM programs could reduce expensive equipment repairs and replacements, it cannot conclude that such programs would be cost-effective for all types of equipment. And since custodians can make vital contributions to effective PM programs, districts should consistently train custodians in appropriate PM work and monitor their PM activity.

Districts should begin their formal PM programs with more expensive equipment because of the greater potential that PM savings will exceed costs. Also, such an approach may prevent districts from becoming bogged down in all-encompassing PM efforts. Granite District told us that a previous PM effort was so encompassing that it was overwhelming and collapsed. Granite's current pilot program in 12 schools in the plumbing area seems well chosen, for that area is where the district's most expensive repairs and replacements are occurring. Still, the district needs to immediately address its need for a boiler PM program at all schools.

When consistently trained in PM procedures and monitored, custodians can be very effective in reducing equipment failure. Because of their daily presence in the schools, they can efficiently perform frequently recurring PM tasks; because they are most familiar with their equipment, they can report unusual noises or conditions for timely repair. Timely reporting alone can save expensive repairs and replacements. An alert Alpine District custodian saved that district several thousand dollars by promptly reporting an unusual noise in a large air handling unit, thus preventing destruction of the unit.

Two conditions are necessary to ensure effective PM work by custodians. Custodians must be consistently trained and the formal PM program must include specific assignments and require return of the assignment notice indicating completion of the work. Also, the completion information needs to be shared with the maintenance department so that its staff knows what equipment is being serviced.

With the exception of Alpine District, which apparently trained its custodians under its former PM program, none of the three districts has consistently trained their head custodians in building equipment PM procedures. No district is presently directing work orders to custodians or requiring them to report when the work is completed. And no district's maintenance department knows what PM work is being done by custodians because they never see even the few reports that custodians may submit to the custodial department.

Recommendations:

1. We recommend that school districts judiciously establish preventive maintenance programs at a pace that can be sustained, beginning with their most expensive equipment.

2. We recommend that school districts train custodians in preventive maintenance work, specifically assign the work, require reports of its completion, and share the completion information with their maintenance department.

We hope this letter provides you with the information you need on the Jordan School

District's maintenance operations, as well as that of the Alpine and Granite Districts. Responses from the affected school districts are attached. If you have any questions or need additional information, please let me know.

Sincerely,

Wayne L. Welsh
Auditor General

WLW:BRP/lm
Attachments

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