

MAINTENANCE EXCELLENCE: AN EFFECTIVE COST-CONTROL TOOL FOR WATER AND WASTEWATER UTILITIES

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ABSTRACT

The requirements of municipal water and wastewater treatment facilities are changing rapidly. Problems created by the prospect of privatization, the constant demand for higher environmental standards, and dwindling funding are forcing public utilities to rethink and re-engineer facility processes involved with Water and Wastewater Treatment Systems.

When focusing on budget and performance issues, historically, management seldom looked to maintenance as an area with the potential for significant gains. However, with these additional pressures and with the advent of CMOM, Asset Based Management and Environmental Management Systems, utilities will be forced to develop maintenance management systems. This paper provides background information, industry-wide statistics and facility specific data from actual assessments from within the water and wastewater industry that should place maintenance in its proper place for management's commitment to serious levels of maintenance system improvement.

There are some alarming statistics for maintenance costs and effectiveness in the public water and wastewater treatment community. Comparing those statistics with "Best Practice" figures dramatically illustrates the potential gains, in terms of environmental goals, total costs and percent of budget reduction that are possible. Maintenance improvement initiatives such as the development of a maintenance management system can, and have produced snowballing effects in overall improvement of treatment plant operations and across the board budget performance. The maintenance system model known as "Maintenance Excellence" will be illustrated and described in overview. Descriptions of an example from Charleston CPW's treatment plant will

demonstrate how a good maintenance management system resolves those problems to focus on plant reliability rather than plant repair issues.

To illustrate the achievability of the potential gains considered, the paper moves on to data obtained from maintenance assessments (audits) performed at actual water/wastewater treatment plants that have implemented Maintenance Excellence. The audit data will provide the before and after measures of performance (operating, environmental and cost associated) for these plants. The paper concludes with an overview of the approach to implementing a maintenance management system.

KEYWORDS

Cost Reduction, Risk Management, Reliability, Maintenance Management System, Budget Performance, Maintenance Excellence

INTRODUCTION

Charleston CPW is a combined water and wastewater utility operating in the Charleston, SC metropolitan area, with a 118 mgd water treatment plant and a 36 mgd wastewater treatment plant. With the implementation of an Environmental Management System using ISO 14001 Registration (Fairey and Cook 2001), the development of a CMOM program (Bickerstaff et al. 2003), and the beginning of development of an Asset Management System, CPW implemented a computerized maintenance management system with the assistance of Life Cycle Engineering Inc. CPW's efforts were given impetus due to a number of reasons, including the prospect of privatization, the constant demand for higher environmental standards, and dwindling funding. As typical of most utilities, these pressures are combining to force utilities to rethink and re-engineer facility processes involved with Water and Wastewater Treatment Systems. Driven by a maintenance function built on redundancy in order to reduce risk has caused maintenance and replacement costs in most water/waste water treatment operations to continue to rise as budgets are being forced to shrink.

UNDERSTANDING THE ROLE OF MAINTENANCE

Management must first focus on the actual definition of maintenance in order to understand how to address the financial and risk issues. In order to do so, it is critical for managers to have a good definition of maintenance:

Maintenance – the act of maintaining

Maintain – (1) keep in an existing state; (2) preserve from failure or decline; (3) to keep ready for use;

1. — *Syn.* preserve, keep, renew, care for, keep prepared, keep in condition, keep in readiness, keep up, control, manage, direct, sustain;

see also **prepare**

1. — *Ant.* waste, neglect, consume.

One is able to find many insights available in the previous definition. Compare the definitive phrases and the synonyms with maintenance as practiced at a typical facility. In addition, it is interesting to compare the antonyms. The question then becomes “If an organization could **maintain** their assets, specifically focusing on matching reliability to the risk, would maintenance costs go down?” Intuitively, the answer must be in the affirmative. And it has been the authors’ experience that many organizations (more than 70% of those contacted) with redundant equipment state they do not know if they are truly maintaining their equipment at the appropriate level.

COST VERSUS RISK

When focusing on budget performance issues, management seldom looks to maintenance as an area with the potential for significant gains. However, maintenance is the largest controllable cost in many utilities assuming the utility has a properly-sized staff.

Studies have shown (Smith 2003a) that:

- As reliability continues to decrease in an organization, costs will increase.
- As reliability continues to increase in an organization, costs will decrease.
- Maintenance costs are inversely-related to reliability.

To illustrate, the data for graph 1 below, “Improvement Potential by Audit Score,” was developed by Life Cycle Engineering (Smith 2003 a), using a complex, lengthy and detailed maintenance assessment process (audit) to determine the current status, effectiveness and equipment reliability of a utility’s maintenance processes. The broad categories audited during their assessments together with average scores of all facilities audited are shown in the table below. *(An average greater than 0.750 of all categories combined represents best-in-class, or what can be defined as Maintenance Excellence)*

Graph 1. Improvement Potential by Audit Score

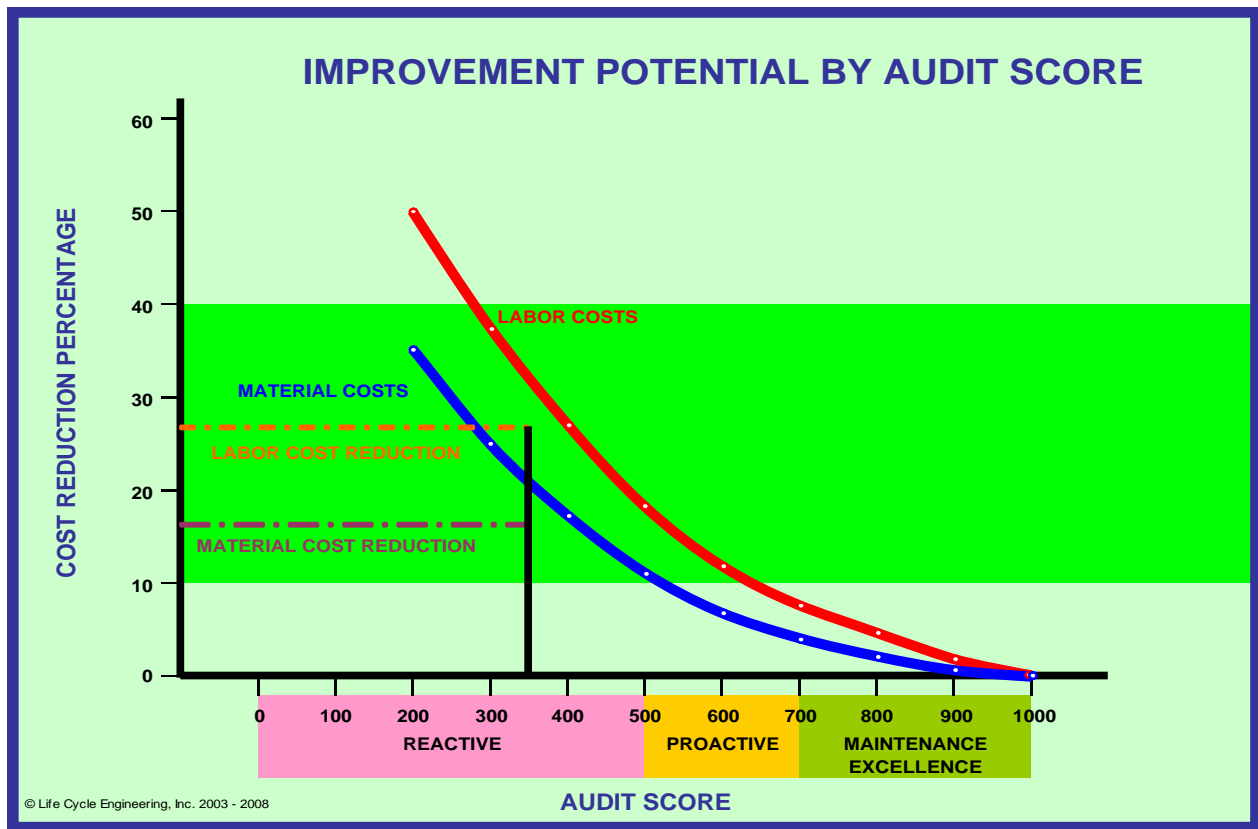
<i>Scores</i>	Governing Principles	Status Assessment	Objectives	Master Plan	Budgetary Control	Management Control	Organization
<i>Average</i>	0.468	0.273	0.388	0.279	0.526	0.471	0.614

<i>Scores</i>	Training	Supervision	Pride & Quality	Facilities & Equipment	Work Order System	Cost Distribution	Computer Support
<i>Average</i>	0.494	0.654	0.585	0.648	0.458	0.438	0.476

<i>Scores</i>	Equipment History	Maintenance Engineering	Preventive/Predictive Maintenance	Work Planning	Work Measurements	Material Support and Control	Scheduling & Coordination
<i>Average</i>	0.444	0.436	0.514	0.355	0.267	0.589	0.395

<i>Scores</i>	Total Scores
<i>Average</i>	0.485

Taking the raw data, then, the following graph 2 illustrates a comparison between improvements made in the maintenance process (as reflected by maintenance audit scores) as they correlate to the potential for reduction in maintenance costs.



Graph 2. Audit Score as a Function of Cost Reduction Percentage.

The graph dramatically illustrates that by improving the maintenance process from reactive to proactive and ultimately to maintenance excellence, maintenance costs can be substantially reduced with the increasing emphasis on maintenance management systems. Statistics for maintenance costs and maintenance effectiveness in the municipal water and wastewater treatment community should cause management to ask: “What are the maintenance *best practices* that must be followed in order to reduce costs and at the same time reduce risk?”

The table below (Smith 2001) provides a list of just some of the “Best Maintenance Practices” together with effectiveness measurements that will allow management to gauge their own utility’s practices against the benchmark values of Maintenance Excellence.

PRACTICE	BENCHMARK VALUE
Maintenance Planning and Scheduling (over 80% of labor hours are scheduled by day)	Scheduled Compliance 90% (labor hrs)
PM Compliance (% of PMs completed on time)	95% Compliance (10% of frequency met)
Maintenance Cost	Increases of less than 1% a year

Stock Outs (percentage of time someone goes to the storeroom and the parts are not in stock)	2%
Urgent / Emergency labor hours	Less than 10% (of total labor hours)
% of Work Orders from PM inspections	90%

Management should then compare its utility's performance statistics with these benchmark values to dramatically illustrate the gains in environmental goals, in percent of budget and finally in total costs, that are possible. Maintenance improvement initiatives such as Maintenance Excellence can, and have produced snowballing effects in overall improvement of treatment plant operations and across the board budget performance.

As a case example, when Charleston CPW first began monitoring its maintenance activity at its Plum Island WWTP, it was discovered that corrective maintenance versus preventive maintenance dominated. In fact, the earliest indicators were....

METHODOLOGY

There are various ways to implement a best-in-class maintenance management system. (Smith 2003b). However, it has been the authors' experience that the process that a water/waste water treatment operation needs to follow in order to reduce maintenance costs as well as risk involves four steps:

Step 1.

Perform a maintenance assessment. In the assessment one must know the level of proficiency in each area of the maintenance operation. Maintenance is a multi-faceted process with interdependencies that preclude improvement in one single operation without corresponding improvements in interfacing operations. In order to have any process achieve stability, each area of interdependence must be examined for those improvements necessary to sustain improvement in the core process.



Step 2.

Develop a Master Plan to implement the maintenance improvement initiative. This master plan must take into consideration the interdependency of each area in the maintenance process. Within the plan must be included a timeline, resource requirements (labor, hardware/software, parts and material, etc.), outsourcing requirements, costs, expected savings, goals (which must be measurable), and major milestones, all integrated together with task and subtask activities.

Step 3.

Work the plan and adjust as needed. Integral to plan execution is the assignment of a *maintenance excellence steering team* along with focus teams for each of the core or primary areas that need to be improved. The team approach is difficult to execute for many employees, but the primary reason for failures in new initiatives is that management tries to direct people instead of empowering them. Employees will do and support what they believe is important and that is why the team approach is so important to ultimate success.

Step 4.

Share successes with all employees. Display the measurements of improvement such as line graphs depicting improvement progress and which demonstrate to all employees that the organization is being successful. It was Dr. Edwards Deming who stated, "You cannot improve something you cannot measure." However, one should be careful to show the right graphs to the right people. For example, upper management will want to see cost. Operations

and maintenance personnel will want to see Mean Time Between Failure or the weekly “Bad Actors” report as well as general cost savings.

In conclusion, a comprehensive maintenance management system is a critical element in any good management program such as ISO 14001, CMOM, or Asset Management, and it essential to reduce cost while improving reliability. Through such a system, overall costs can be reduced, system reliability improved, and the utility’s overall goals of improved environmental management can be achieved.

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