Driving Change in Maintenance - Maintenance Metrics

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The Massachusetts Water Resources Authority (MWRA) is responsible for providing wholesale water and sewerage services, in whole or in part, to sixty-one communities, and 2.6 million people. In addition to its operating responsibilities, MWRA is responsible for rehabilitating, repairing and maintaining the regional water and sewerage systems. Since its assumption of the ownership and operations of these systems in 1985, MWRA has undertaken an ambitious program of water and wastewater system capital improvements with estimated expenditures for fiscal years 1986 through 2009 of over $7 billion. Under one massive construction effort, the Boston Harbor Project, the MWRA assumed maintenance responsibility of the $3.8 billion dollar Deer Island Treatment Plant (DITP). As the second largest wastewater treatment facility in the nation, it is designed to treat 1.2 billion-gallons-per-day.

In addition, the Agency had embarked on several other large capital projects that would require similar asset care including a new water filtration plant. Given the significant value and critical nature of the MWRA assets, maintenance is of paramount importance. In 1996 the Facilities Asset Management Program (FAMP) initiative was created as a comprehensive, agency-wide effort to most efficiently and effectively manage the region's water and sewer infrastructure.

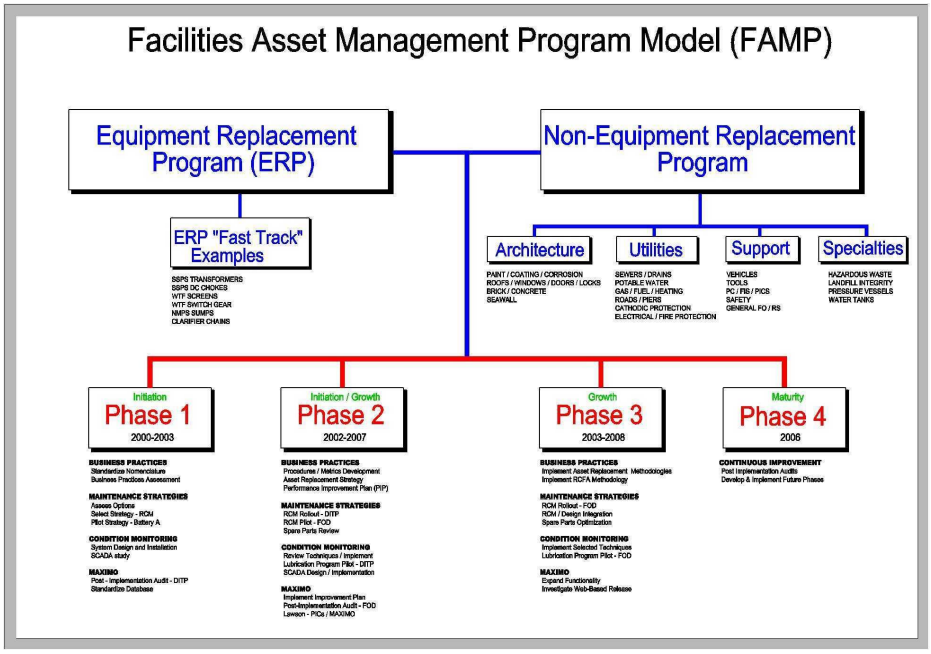
OBJECTIVES

The purpose of the FAMP initiative is to optimize the efficiency and effectiveness of MWRA maintenance practices (i.e. minimize critical equipment failures, minimize unnecessary maintenance practices, improve equipment reliability, heighten system knowledge and lower overall maintenance costs). In summary, the program is focused on standardization of maintenance practices, adoption of best practices and optimization of labor and material resources. The program is a multi-year phased approach as shown on Figure 1.

One program element includes the development of leading and lagging metrics (key performance indicators) for the maintenance component of the Facilities Asset Management Program. The metrics developed were selected to drive change, higher plant reliability, and monitor the performance of new maintenance initiatives.

A task team was formed to review the existing maintenance metrics and recommend new metrics. Metrics from maintenance text books, papers, and the internet were

researched and reviewed for the Deer Island Treatment Plant. The selected metrics were for maintenance productivity and proactive maintenance programs. Metrics were selected to drive change in an organization (leading metrics) and metrics that measure the success of changes implemented (lagging metrics).



Everyday Metrics

The statement at the start of the MWRA monthly metrics report is "What gets measured, gets managed". Leading metrics are the drivers for timely implementation of new programs and organizational priorities. A great example of a leading metric is one used by McDonalds. McDonald's set goals and targets for the Total Time in Line (TTL) for the drive through window. At one McDonald's visited, the TTL goal was:

The total time in line should not exceed 130 seconds for 90% of the cars

The server knew the goal and stated that the goal was watched closely by supervision every work shift. This type of metric drives the workers at McDonald's to be very cognizant of the time to serve customers and is a way to modify employee behavior and drive change. This metric also reveals that workers in an organization can change behavior if goals and expectations are measured and communicated. What gets measured, gets done.

In the McDonald's example given above and actual results, management changes such as staffing can be made after reviewing the results of measuring the total time in line. If an analysis of the TTL exceeds the goal for certain time periods of the day, a metric with staffing levels throughout the day could be analyzed against TTL. Then additional staff could work during those time periods to decrease the TTL. Ultimately, another metric measuring the reduction of TTL would be increased sales in the drive through line. The staffing and sales metrics are lagging metrics that can be used to determine if decreasing TTL increases the overall efficiency of the McDonalds. These metrics are considered lagging because they measure the results.

Metric Selection

To select the metrics to be used at the MWRA Deer Island Treatment Plant a task team of maintenance, work coordination, and planning staff, and management met monthly to discuss metric selection. The task team worked on the following:

- Charter development
- Review of available metrics
- Selection of candidate metrics
- Preparation of candidate metrics with actual data
- Senior management agreement on select final metrics
- Changes to computerized maintenance management software (CMMS)
- Results
- Tracking to monitor change

Charter Development

A charter was developed for the task team to define the team mission/objective, members, deliverables and schedule, and expected benefits. The charter was agreed upon by the task team and provided the guidelines for task team meetings and goals for deliverable completion.

Review of Available Metrics

There are many industry-wide maintenance metrics that are available for use. The metrics chosen for a facility need to be tailored to match the goals of the organization and the current state of the asset management and reliability initiatives. For example if an organization is in the process of implementing a CMMS, metrics associated with the CMMS could be tracked such as % equipment in CMMS, % hours/total labor hours in CMMS, or % equipment with preventive maintenance schedules.

The task team reviewed industry metrics from maintenance handbooks, industry papers, and reliability web sites. One good resource for maintenance metrics was the papers presented at the Society for Maintenance and Reliability Professionals (www.smrp.org) In addition to identifying metrics, industry benchmarks or goals were also identified for each metric.

Selection of Candidate Metrics

The task team reviewed each metric and determined the appropriate metrics for the current state of our maintenance program. A description of each metric was developed, the benefit of using each metric described, and a recommendation on using the metric. The task team then developed a listing of candidate metrics to be presented to the steering committee.

The metrics recommended for implementation included the following:

Productivity Metrics

1. Kitting - Used to increase Wrench Time
   Definition
   Wrench time is the amount of time a maintenance technician is performing the actual field work excluding travel, standby time, or waiting for parts. Kitting is a process where parts are put together prior to being required for work by warehouse staff for use by maintenance technicians. Kitting increases wrench time by minimizing time waiting for parts.
   Benefit
   This metric can drive productivity improvements in management, scheduling or improved warehouse service.
   Recommendation
   Use metric. Implementation of this metric will require changes to the various maintenance organizations to implement. The planners will need to identify parts to be kitted in the CMMS and notify the warehouse when the parts are required. The warehouse will then need to assemble the parts and deliver them to the job area. The first efforts will be load all PM material into the CMMS and work to kit preventive maintenance parts.

2. Percent Light Maintenance by Operators
   Definition
   The ratio of completed PM hours by Operations staff divided by the total PM hours.
   Benefit
   This metric will trend the move to a more cross-functional operational team as a result of the productivity improvement program. This metric will detail the transfer of minor maintenance PM tasks to operations.
   Recommendation
   Use metric. A report will need to be developed in the CMMS to have a report that can determine this metric automatically.

3. Backlog
   Definition
   The estimated work hours for "in progress" work orders divided by the available staff hours each week.

Benefit

This metric is helpful to gage whether there is adequate staff to complete the maintenance work. Increasing backlog can be attributed to increased equipment problems or a decline in maintenance efficiency. It also can be used to assess the backlog of each trade. This metric has been helpful in determination of whether specific trade back fills are necessary. The industry guideline is to have a backlog of 4 to 6 weeks. This metric is currently used and all reports for its use are available in Maximo.

Recommendation

Use metric. The CMMS currently has a report to determine this metric.

Proactive Maintenance Measures

1. PM % complete

Definition

Ratio of total number of preventive maintenance work orders completed divided by the total number of preventive maintenance work orders issued.

Benefit

The completion of preventive maintenance work orders ensures equipment is provided with the required maintenance to extend equipment life and to reduce the number of corrective maintenance work orders. A long term goal of 100% PM completion is recommended. This metric drives maintenance to be more proactive.

Recommendation

Use Metric. The CMMS currently has a report to determine this metric.

2. Predictive Maintenance (Pdm) % of work Orders

Definition

The ratio of work orders that are for predictive maintenance using predictive/condition monitoring techniques compared to the total number of work orders.

Benefit

With properly selected goals this metric can drive maintenance to become more proactive. Benchmark goals are > 35-40 % predictive. Pdm tasks monitor equipment health and therefore reduce catastrophic failures of critical equipment, increase equipment availability, and allow for planned maintenance for equipment repairs.

Recommendation

Use metric. Corrective (CM), Emergency (EM) and Preventive (PM) work orders are currently tracked in the CMMS. Pdm tasks will need to be added to the CMMS. This requires reviews of existing CMMS job plans to change some PM tasks to Pdm tasks. In addition, the existing CMMS reports will require modification. It is expected that the implementation of RCM will increase the Pdm tasks and decrease the EM and CM costs to benchmark levels.

3. Percentage of OT

Definition

The cost of overtime as a percentage of wages and salaries.

Benefit

This metrics is used to track and monitor overtime usage. A lower overtime usage is an indication that maintenance activities are less reactive. This metric is currently used effectively by the Authority. The benchmark best in class goal is less than 5%

Recommendation

Use metric. A report is available in the CMMS to determine overtime spending.

Preparation of Metrics with Actual Data

Each candidate metric was prepared with actual data extracted from the CMMS. Metrics were developed graphically using Microsoft Excel with results detailed each month. A variety of formats were presented to the steering committee to review. The preparation of metrics with actual data helps the senior management understand the current state of new metric along with the goal selected.

Senior Management Agreement

Maintenance metrics have been prepared for many years prior to the formation of the Facility Asset Management Program. Senior management requested a review of the existing maintenance metrics to integrate the new maintenance initiatives started as part of FAMP.

The development of new metrics always includes some education of the definition of the new metric, purpose, and ultimate goal. Each metric proposed to senior management was presented and discussed with the task team. Senior management selected metrics that supported new maintenance initiatives and supported the changes being made to the maintenance organization. At the completion of the task team meeting the selected metrics were implemented.

Senior management agreement on the metrics was imperative for successful implementation. The metrics developed are published monthly internally for review by staff. Each month these metrics are reviewed by senior staff and progress on each metric discussed.

Changes to Computerized Maintenance Management System (CMMS)

Several metrics selected required changes to the CMMS to easily retrieve and report this information monthly. A consultant and the Authority MIS department developed new reports in Maximo to easily determine the metric completion values for each month.

Tracking Metrics to Drive Change

The selection of the metrics is the first step in driving the change for new initiatives in maintenance. A plan needs to be developed for each metric to reach the metric goals selected. In the case of the Operation Light Maintenance Goal, maintenance and operations staff met monthly. The staff reviewed the existing preventive maintenance work orders and identified work orders that were suitable for Operation staff to complete. Agreement was reached and changes were made in the CMMS to assign these PMs to Operations. Operations also developed a plan to distribute the PM work load to the off shifts to minimize the impact to the overall Operations. This plan was successful and additional PMs continue to be transferred to Operations.

Results

The metrics selected were productivity and proactive maintenance metrics. Both leading and lagging metrics were selected to drive and monitor changes in the maintenance program. A discussion of each metric and the positive results obtained to date are given below:

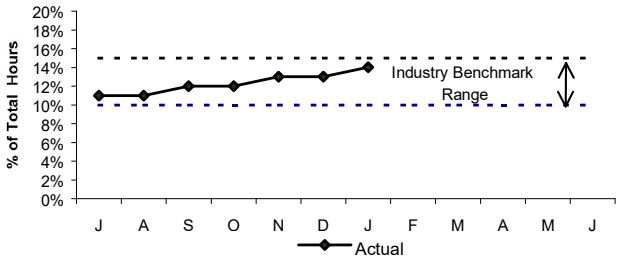
Productivity Metrics

The leading metrics to for operations staff to complete more light maintenance and the maintenance planners to kit of preventive maintenance work orders are efforts to reduce the lagging metric for maintenance backlog. As detailed below these efforts have been successful.

Productivity Metrics	**Leading**		**Lagging**	
	Operations Light Maintenance %	↑	Backlog	↓
	Kitting Preventive Maintenance %	↑		

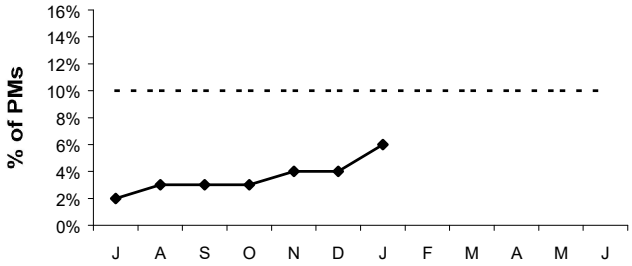
1. Operators performing light maintenance - As part of implementation of the Productivity Improvement Program, Deer Island has increased the percentage of preventive maintenance tasks completed by Operations staff from 1% in January 2002 to 14% by January 2004. This equates to approximately 500 hours per month or approximately four Full Time Equivalent Employees. The long-term goal was reached that 10-15% of all PM hours being completed by operators.

Operations Light Maintenance PMs

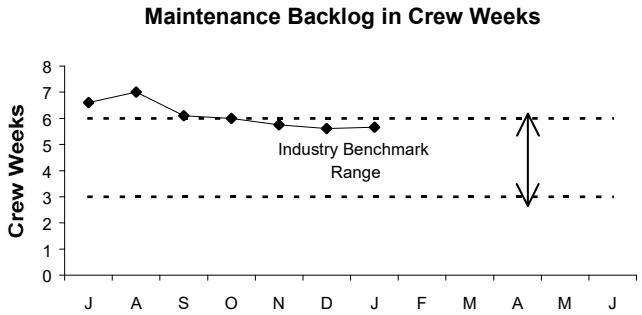


2. Kitting - Deer Island has kitted all HVAC filters for all areas of the plant. Each month the planner provides a listing of required filters for the next month preventive maintenance work orders. The warehouse then prepares pallets with the required filters, which are then delivered to the associated plant area. This effort has increased the HVAC technician's available time to complete more work by eliminating the time waiting for parts. The planners at DITP are working on kitting the remaining preventive maintenance tasks. The short-term goal is to kit 10% of all Preventive maintenance parts.

Preventive Maintenance Kitting



3. Backlog - Deer Island is within the industry standard for backlog (3-6 weeks). Through continued kitting and increasing operators performing light maintenance DITP should be able to maintain its backlog within industry standards with the recent staff reductions from early retirements. The backlog at Deer Island has decreased from 8.5 weeks in 1999 to 5.8 weeks today.



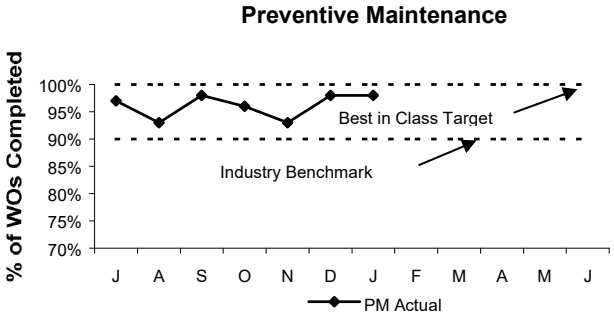
Proactive Metrics

The leading metrics to complete all preventive maintenance work orders each month and increase the number of preventive maintenance work are efforts to reduce the lagging metric for maintenance overtime. As detailed below the goals for the lagging metrics are on track for successful completion. The lagging metric for overtime was impacted by staff attrition due to early retirements and after staff back fills have been completed the overtime is in the below the benchmark goal.

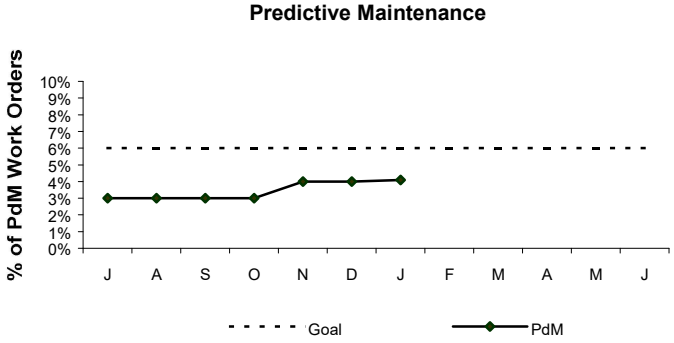
Proactive Metrics	**Leading**	**Lagging**
	Preventive Maintenance % Complete ↑	Overtime % ↓
	Predictive Maintenance % ↑	

Commented [J1]:

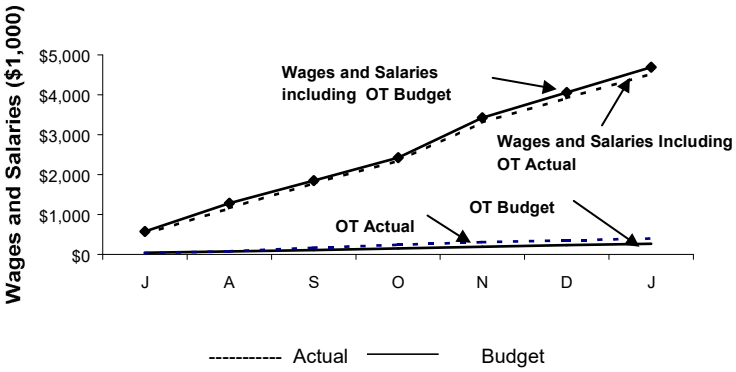
1. PM% Complete - This metric is a focus on DITP. A report is available to access daily from all DITP PCs to track the completion of PMs by each maintenance supervisor. This report is used by all maintenance managers and discussed each Thursday at the maintenance managers meeting. The goal for this metric was increased from 85% to 100% in March 2002. As a result the PM% complete average has increased from 88% in 2002 to 92% (to date) in 2003. The improvement in this metric has helped maintenance maintain equipment availability (>97%) and maintenance backlog within industry benchmarks.



2. Predictive Maintenance % - This is a new metric to focus on increasing the amount of predictive maintenance for the plant. Some condition monitoring is completed by contractors such as vibration analysis and electrical testing (including thermograhy and oil analysis) for medium and low voltage equipment. In house staff are working to expand the condition monitoring efforts in vibration, acoustic ultrasonics, ultrasonic thickness and oil analysis.



3. Percentage of Overtime - The percentage of OT is an indicator of reactive maintenance. The amount of OT was been within the industry benchmark of 5% for FY03 through January 2003. A recent early retirement program reduced staff significantly and required additional OT spending to compensate for lost employees to maintain the backlog. The additional OT spending was more than offset by the reduced wages and salaries from the retirement of employees.



Conclusion

Multiple maintenance metrics are needed to compare trends in different areas to assess maintenance performance. A diverse group including senior management need to be involved in the selection of the metrics with a schedule to select the metrics, prepare proposed metrics, and then finalize and implement the metrics.

The metrics developed for the Deer Island Treatment Plant have been implemented for over one year and have been successful in moving plant forward in both productivity and proactive maintenance initiatives. Also, the metrics have helped inform management of the status of the maintenance program.

"What gets measured, gets managed"