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Process also establishes staffing needs.

Currently many maintenance budgets are developed based on previous maintenance budgets or a percentage of the replacement asset value (RAV) of maintained equipment. Sometimes maintenance budgets and staffing decisions are based on negotiations between management and the maintenance department. Often an exacting method of determining the specific number of maintenance technicians and their required skill set is not in place.

This article presents a method of establishing a defendable zero-based maintenance budget and staffing requirements based on equipment requirements and company goals that are supported by documentation. Decisions regarding budgeting and staffing are based on facts instead of emotions or educated guesses. Key areas for optimizing equipment expenditures and staffing requirements are easily identified.

Step 1. Determine the maturity of your maintenance and reliability program

The ability to establish, control, and predict a maintenance budget is directly related to the maturity of a maintenance and reliability program. Maintenance and reliability professionals often describe the maturity of a program in distinct phases, levels, or steps. It is important to understand the level of maturity of the maintenance program in a plant prior to attempting to develop a budget.

Typical phases in the maturity continuum of a maintenance and reliability program can be seen in the accompanying text " Maturity Continuum of a Maintenance and Reliability Program ."

Maintenance and reliability practitioners often debate the actual number of phases and what programs or systems should be included in each phase. The phases and the programs or activities associated with each phase are listed as an example of a typical progression of a maintenance program.

A maintenance and reliability program must be built in phases. It is important to have the Phase 1 programs and systems in place prior to developing Phase 2 programs and activities. Phase 2 programs and systems must be in place prior to effectively developing Phase 3 programs, etc.

A maintenance budget and staffing needs are best controlled when the maturity of a maintenance and reliability program has progressed to Phase 3. The more the maintenance and reliability program has progressed, the easier it is to control the maintenance budget.

Step 2. Determine how your maintenance budget and staffing levels compare to those of your competitors

It is important to determine how your maintenance budget and staffing requirements compare with those of your competitors. If you are spending too much on maintenance, you cannot be competitive. If you are not spending enough on maintenance you will be under-maintaining your assets and your equipment will start to deteriorate.

A method of determining how your maintenance budget compares with those of your competitors is to compare your maintenance expenditures and staffing levels to the RAV of your plant. The RAV is the amount of current dollars that would be required to replace the assets in a plant. Benchmarks for the maintenance budget as a percent of RAV and the number of maintenance technicians compared to the RAV are available for most industries.

The more advanced a maintenance program becomes; the less money will be spent on maintaining equipment. Fig. 1 shows typical RAV maintenance costs for a few generalized industries.

Step 3. Develop an equipment hierarchy

To properly manage a maintenance and reliability program, and a maintenance budget, an equipment hierarchy must be established. Equipment hierarchies are not “standardized” in the maintenance and reliability community. Typically, the methodology for developing a hierarchy for a specific company is standardized across a company.

See accompanying text “ Typical Equipment Hierarchy ” for a hypothetical chemical company. This hierarchy has been developed for use in this article.

Step 4. Understand methods used by your corporation and local plant to track and control maintenance expenditures and develop a maintenance budget for each asset

Corporate maintenance metrics are typically developed to reflect the performance of assets identified in Level 1 through Level 3 of the hierarchy. An associated metric might be the total cost to produce a thousand pounds of polymer per maintenance dollars spent. It is difficult to control maintenance expenditures at Levels 1 through 3.

Individual plant maintenance metrics are typically tracked for each department and each production area (Levels 4 and 5). Many plants can easily track production costs for each department and each production area of the plant. At most plants, an attempt is made to control the maintenance budget at these levels. Although the costs can be easily tracked, it is difficult to control maintenance expenditures at these levels.

Costs to maintain individual assets can be effectively developed and maintained only at the asset level (Level 7).

Consider the following:
•Observation made at company level (Level 1): We are not competitive. A key reason is that maintenance costs are too high.
• Observation made at the business unit (Level 2): The maintenance costs at the chemical plant in Mobile, AL, are too high. The costs of maintenance at the chemical plant in Macon, GA, are at an acceptable level.
•Observation made at the production unit level (Level 6): The cost of maintenance for Reactor #3 is too high. (Note: Although the source of the high maintenance costs, Reactor #3, has been identified, the reasons for the high maintenance costs have not been identified and cannot be controlled.)
• Observation made at the individual asset level (Level 7): The cost of maintenance is high primarily due to failures of the reactor vessel. The vessel continues to develop leaks. It is often necessary to shut down the vessel and build scaffolding inside the vessel in order to repair the leak. There have been four serious leaks in the reactor vessel within the past 8 months. The costs are generated at this level. This is where the costs must be controlled.

Typically maintenance budgets are developed and managed at levels above the asset level (Level 7), but maintenance budgets can best be developed and managed at the asset level. Each asset should have a budget that includes material and labor. Once a budget is established for each asset, the budget for the department and plant can be determined. See accompanying text " Budget Example for a Specific Asset ."

Step 5. Control maintenance costs using the maintenance budget

A budget developed at the asset level can be used as a tool to reduce and control costs, determine manpower requirements, identify training needs, and develop business cases.

•Reduce and control costs. Review the Budget Example for a Specific Asset. All the tasks shown are preventive maintenance, time based, tasks. Costs can be reduced by performing predictive maintenance tasks.

For example, vibration monitoring can be performed on the pump and the bearings can be replaced when they start to fail. The mean time between failures can be predicted by determining the B10 life of the bearing. The budget then would be modified as shown in " Modified Budget Example for a Specific Asset."

The costs for maintaining the equipment based on the initial maintenance plan can be compared to the costs for maintaining the equipment as shown in the "Modified Budget Example for a Specific Asset." Any cost savings are easily identified.

On a regular basis, the actual cost of maintaining each asset should be compared to the budgeted costs of maintaining the asset. Any over- or underexpenditure should be addressed on an asset-by-asset basis. By controlling the expenditures on each asset the overall maintenance budget is effectively managed.

•Determine manpower requirements. Manpower requirements can easily be determined by using the individual budget for each asset. In the example, the specific manpower requirements are identified by craft. The overall manpower requirements for each craft can be developed by combining the manpower requirements required to maintain each asset.

If more resources are needed to maintain equipment, the information required to justify an increase in staffing is available. If a reduction in manpower is required, the maintenance manager can work with plant supervision on an asset-by-asset basis to determine which maintenance tasks will no longer be performed.

• Develop business cases. Information from the zero-based budget can be used to create business plans for improving the maintenance of the plant. How many times have you attempted to improve maintenance at your plant but could not convince management to support the effort? It is much easier to convince management to support an effort if an effective business plan is developed to support your case.

In the example above, vibration analysis was used to extend the life of the bearings. To start a vibration analysis program at a plant, one could modify the budget for each piece of equipment that has the potential to be monitored. The costs savings then can be identified.

The increase in manpower due to the addition of a vibration analysis program to your existing maintenance program can be developed. The decrease in manpower brought about by replacing bearings based on the bearing's condition as opposed to the time the bearing had been in service can be calculated. Once the cost of developing the vibration analysis program is determined, the payback for implementing a vibration monitoring program can be calculated.

• Develop a budget, staffing, and training plan for each asset. If a budget is developed for each asset the following items can easily be developed:

1. A maintenance staffing plan that identifies and supports the number of technicians, by craft, required to maintain the plant.

2. A specific training plan because all tasks that will be performed are identified. Technicians can be trained to perform the specific tasks identified in the budget.

3. An overall maintenance budget that can be defended.

4. A justification for increasing or decreasing the maintenance budget when pieces of equipment are installed or removed.

5. A justification for increasing the maintenance budget if an asset is utilized more than it has been in the past. If an asset is utilized more, the specific budget for the asset must be modified to reflect any increases in maintenance expenditures required to ensure that the equipment can be operated reliably.

6. A basis for a business plan that will support maintenance improvements.

•Utilize zero-based budgeting to develop life cycle costing. The process that is used to develop budgets for individual assets can be utilized in a life cycle cost analysis. Life cycle costing is part of a world class, reliability centered maintenance–advanced reliability program.

For the purpose of this article, life cycle costs are listed as a Phase 5 activity in the development of a maintenance and reliability program. The total cost of maintaining an asset along with the manpower needed to maintain the asset should and can be considered during the project delivery phase of the project. Various alternatives with various life cycle costs can be evaluated.

Call to action

It is important to understand the current methods that are used to establish maintenance budgets within your organization. Is there a well-thought-out method of developing a maintenance budget? Or is last year's budget simply increased or decreased by an arbitrary amount to develop this year's budget?

Determine the maturity of your maintenance program and benchmark your maintenance costs with those of your competitors. The cost of maintaining equipment vs the RAV for various types of manufacturing plants is available. The information on the cost of maintaining a plant based on the maturity level of the plant's maintenance program is also available. By gathering this information, you can answer such questions as how much your plant could benefit from maintenance improvements and whether you are spending too much or not enough on maintenance.

Either develop an equipment hierarchy for your facility or validate the existing hierarchy. An

equipment hierarchy is a vital element of any maintenance program.

Control your maintenance budget. Do not let your maintenance budget control you. By controlling maintenance expenditures at the asset level, the overall maintenance budget can be managed effectively.

Determine your specific staffing requirements and training needs. An asset-based equipment budget will provide this type of detailed information.

Consider incorporating asset life cycle costing into your capital deliver program. **MT**

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Maturity Continuum of A Maintenance and Reliability Program

Typical phases in the maturity continuum of a maintenance and reliability program are as follows:

Phase 1: Reactive Maintenance/Firefighting

- Lack of formalized maintenance program

Phase 2: Basic Maintenance

- Equipment hierarchy
- Computerized maintenance management system (CMMS)
- Work order system
- Planning and scheduling
- Preventive maintenance program
- Reliability metrics
- Basic maintenance skills program

Phase 3: Proactive Maintenance

- Predictive maintenance program
- Equipment history documentation
- Root cause failure analysis
- Advanced maintenance skills program

Phase 4: Advanced Maintenance

- Autonomous maintenance (maintenance performed by operators)
- Shutdown, turnaround, outage optimization
- Maintenance craft flexibility development
- Optimizing asset performance

Phase 5: World Class, Reliability Centered Maintenance, Advanced Reliability Maintenance

- Reliability centered maintenance (RCM)
- Life cycle costing
- Reliability analysis of existing assets
- Standardization of equipment

back to article

Maintenance Budget Based on RAV

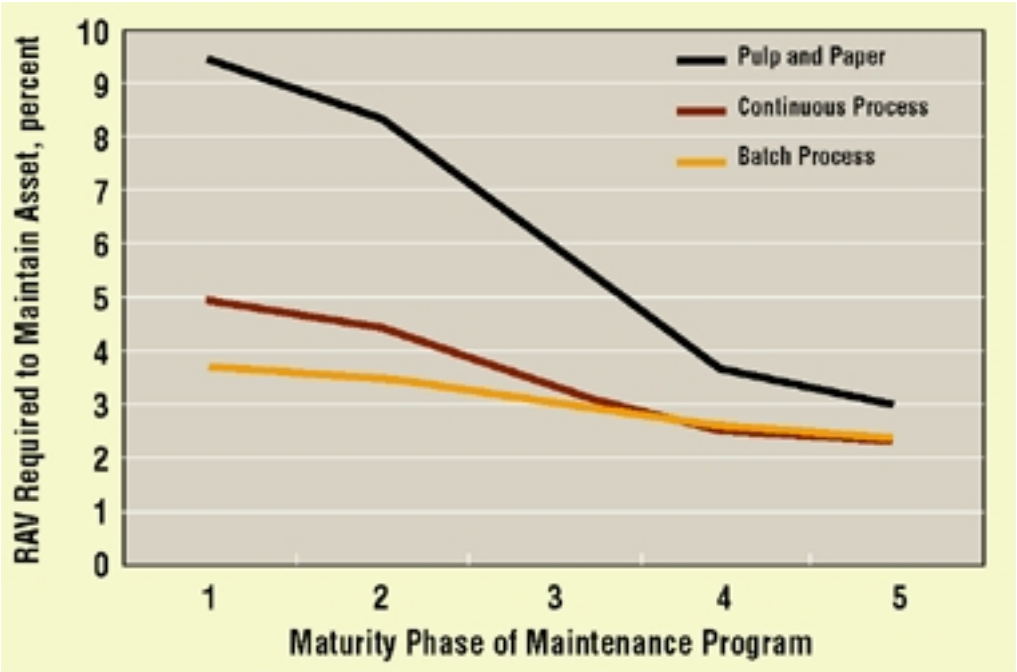

Fig. 1. This shows typical replacement asset value (RAV) maintenance costs for a few generalized industries. The more advanced a maintenance program becomes; the less money will be spent on maintaining equipment.

back to article

typical equipment hierarchy

Here is a typical equipment hierarchy for a hypothetical chemical company. The hierarchy h

1. Company, ACME Chemicals Level 1

Level 1

1.1
1.2
1.3

Business Unit, Plastics
Business Unit, Solvents
Business Unit, Specialty Chemicals

Level 2

1.3.1
1.3.2

Polymer Plant, Macon GA
Polymer Plant, Mobile, AL

Level 3

1.3.2.1
1.3.2.2
1.3.2.3
1.3.2.4

Department, Raw Materials/Receiving
Department, Shipping/Packaging
Department, Utilities
Department, Production

Level 4

1.3.2.4.1
1.3.2.4.2
1.3.2.4.3

Production Area, Formulation
Production Area, Filtrantion/Blending
Production Area, Polymers

Level 5

1.3.2.4.3.1
1.3.2.4.3.2
1.3.2.4.3.3

Production Unit, Reactor #1
Production Unit, Reactor #2
Production Unit, Reactor #3

Level 6

1.3.2.4.3.3.1
1.3.2.4.3.3.2
1.3.2.4.3.3.3

Asset, Polymer Reactor
Asset, Reactor Heat Exchamger
Asset, Circulating Pump

Level 7

back to article

Budget Example for a Specific Asset

Equipment Name: Circulating Pump, Reactor #3

Labor Required

Task

Frequency

Mat'l Cost

Mech

I&E

Lubr.

Helper

Adjust packing

Twice/wk

$0

0.25 hr

Replace packing

Twice/yr

$22

1 hr

1 hr

Change oil

Once/mo

$15

0.45 hr

Replace bearings

Once/2 yr

$853

8 hr

0.5 hr

8 hr

Meg motor

Once/yr

$0

1 hr

Modified Budget Example for a Specific Asset

Equipment Name: Circulating Pump, Reactor #3

Labor Required

Task

Frequency

Mat'l Cost

Mech

I&E

Lubr.

Helper

Adjust packing

Twice/wk

$0

0.25 hr

Replace packing

Twice/yr

$22

1 hr

1 hr

Change oil

Once/mo

$15

0.45 hr

Preform vibration monitoring

Once/mo

0.5 hr

Replace bearings

Estimated every 6 yr

$853

8 hr

0.5 hr

8 hr

Meg motor

Once/yr

$0

1 hr

back to article

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