Achieving Success in Reliability:

Improvement Initiatives

By Jim Davis, CMRP

Introduction

In an industrial environment, maintenance is generally considered one of the most important activities utilized for improving reliability. Because of this, it's also the first activity to be blamed for a lacking or poor performance. If production goals are not met, or if there are quality, safety or environmental issues, maintenance is often seen as the guilty party.

Fortunately, there is a growing culture change toward the way we look at reliability and the way we think of maintenance. Over the last few years, the expectations for the maintenance function within an organization have changed more than any other industrial discipline. Equipment is more complex and sophisticated. There are much higher business expectations related to the results and performance of the maintenance function and, to complement it all, there are many more methodologies, tools and equipment for predicting and preventing maintenance-related failures than ever before.

Today, managers feel the pressure to respond to these changes and an increasing pressure to achieve higher plant availability and lower costs; as a result, there is a growing awareness of the effect of maintenance on safety and the environment. This is accompanied by a growing awareness of the connection between maintenance and product quality and an increasing pressure to achieve higher plant availability at lower costs.

Everything said above, in association with reliability, typically refers to the maintenance function, not just the maintenance department. The maintenance function is a responsibility shared by every department in the plant. The production department is responsible for operating the equipment within its established parameters, to perform certain tasks to maintain the equipment within those parameters, and to report operating anomalies to the maintenance team so corrective actions can be planned and scheduled. The quality department is responsible for monitoring the production process and should report any deviation from standard specifications. The human resources department is responsible for ensuring the skills and capabilities of the employees are adequate for the different job functions associated with maintaining the plant's assets.

Before any effort to improve asset reliability has any chance of success, all departments and personnel, managers and workers alike, must have a complete understanding of the process and a firm commitment to support its implementation.

The following are steps that should be followed to ensure success in the development and implementation of an asset reliability improvement project:

Management Support

Corporate and general manager support is the essential foundation to (A) allow the personnel to participate in the reliability analysis meetings and (B) to manage and support the implementation of the recommendations resulting from the analysis process.

Management becomes part of the team that will audit the results of the reliability improvement project at the end of the analysis. During the process, they should be routinely informed of the progress of the project, major findings and other identified issues encountered during the analysis.

Reliability Project Team

The Reliability Project Team is a multidisciplinary group consisting of operators, craftsmen, supervisors, engineers, etc.... and a facilitator who leads the team through the analysis process. This group typically knows the most about the equipment or system to be analyzed and provides important information about the asset that is not easily found in most data bases. This group may also include experts in the design and the process in question. The main responsibilities of this team are to define, by consensus, how the asset should be operated, how it should be maintained and if there is the need for redesigning parts or all of it.

The primary goal of the Reliability Project Team is to ensure the right combination of maintenance activities are performed at the right time with the right people. The second goal is to ensure the equipment is operated in a way that maximizes the opportunity to achieve a reliability level that is consistent with the safety, environmental, operational and financial (profit) goals of the organization. This is achieved by addressing the basic causes of system failures and ensuring there are organizational activities designed to prevent them, predict them or mitigate the business impact of the functional failures associated with them.

The facilitator doesn't need to be an expert in the design or operation of the asset, but he does need to be a skilled group leader capable of guiding the team to acquire the most knowledge possible of the asset in order to make the decisions required to make the asset perform to expectations.

See Figure 1 for an outline of the team's structure and responsibilities.

The Operating Context

One of the most important aspects of a successful reliability project consists of agreeing on the desired parameters of operation of the plant, line or equipment (assets) involved with the reliability initiative. This means there must be an agreement at all levels and in all key departments of the plant as to the following:

- Production goals for the period (year)
- Production capabilities for the periods between shut downs
- Number and length of required shutdowns
- Design parameters (Drawings, P&ID's, Operating manuals, Maintenance manuals)
- Process flow diagrams
- Market conditions
- Maintenance, reliability and operations (MRO) supplies and inventory

Another aspect covered at this time is the understanding of how much the present problems with the asset are costing the business. The goals of the reliability initiative, as well as the potential benefits of improvement, should be clear. The following should be calculated to the best of the team member ability and knowledge and the data available:

- Unscheduled downtime
- Cost of repair in excess of normal wear and tear (labor and materials)
- Cost of unacceptable quality
- Cost of running at lower than required production levels
- Cost of excessive use of raw materials
- Cost of waste

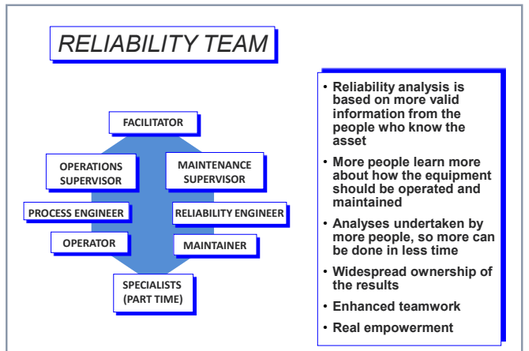

figure 1

The Functions, Functional Failures and Potential Failures

Once the operating context is defined, the team can continue to define the functions of the equipment or system and the functions of its individual components. This step is also very important in allowing members of the team to understand the technical and operational aspects of the asset being analyzed.

There is a level in the equipment hierarchy (Figure 2) where maintenance is applied; there is also the level where most of the causes of the failures occur. These hierarchies should be defined by the reliability team. The team should keep these levels clear in order to define the failure modes and the proactive tasks at the adequate level. If the guidelines are followed, the analysis will result in an optimized maintenance program within an acceptable time frame.

Every facility is uniquely designed to produce a desired output. Whether that output is tires, construction materials, gasoline or paper, the equipment is put together into systems that will produce the end product. Each facility may have unique equipment items, but in many cases common types of equipment are just put together in different ways. Within every reliability analysis we have two types of functions. The first function is the Main or Primary function, which describes the reason for acquiring the asset and the performance standard we expect it to maintain. The second, the Support Function, lists the functions of each component or maintainable item that makes up the system. The support functions are provided by the bottom level of equipment in most facilities such as pumps, electric motors, valves, rollers, etc. Each of those maintainable items has one or more easily identifiable functions that enable the system to produce its required output. It is the loss of these functions that lead to variation in the main or primary function of the system and the safety, environmental, operational and profit output of the facility.

When describing equipment functions, we are interested in what the equipment does in relation to its operating context, not what it is capable of doing.

There are functional failures and potential failures. Functional failures are usually found by operators, while potential failures are typically found by maintenance personnel. In many organizations, there are great debates about what constitutes a failure. If we consider a failure as an unsatisfactory condition, this definition allows us to grasp the idea that equipment can continue to operate yet be considered failed or failing. Many condition monitoring programs don't achieve their desired results because those running the program do not recognize that a failure has occurred as soon as an unsatisfactory condition is detected. The purpose of the reliability team is to define the function parameters, decide when the operating condition becomes unsatisfactory and establish those parameters as the failure state or functional failure. (See Figure 3)

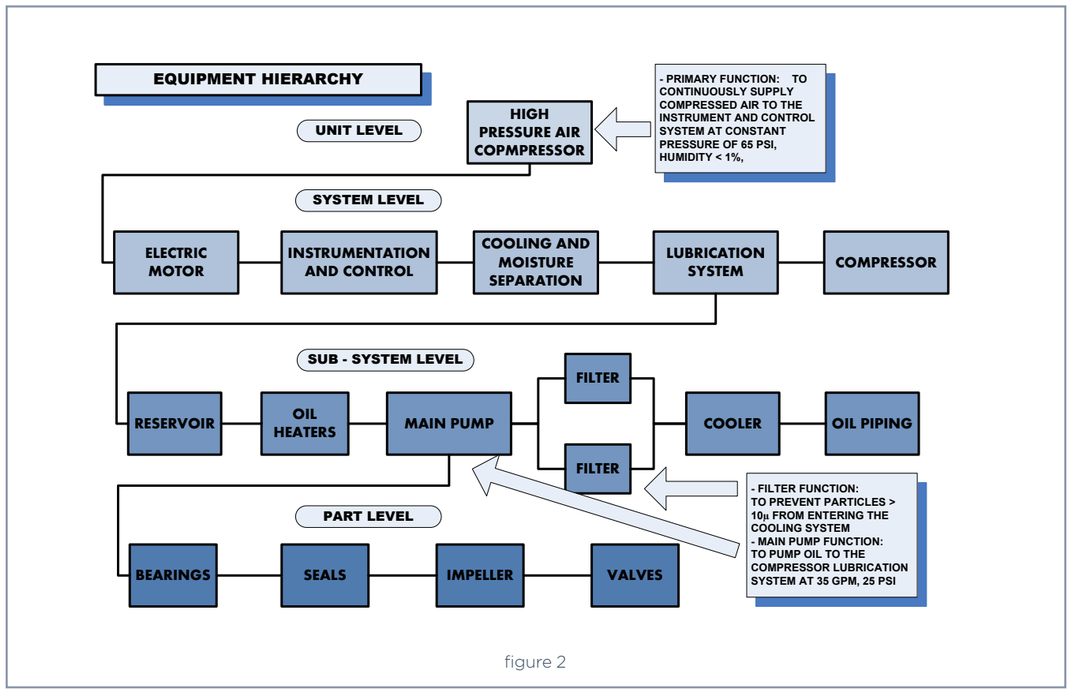

figure 2

Defining Failure Modes

At this point, the reliability team knows enough about the asset to be able to define the ways the asset could fail to fulfill its function. Also, the team is ready to establish the tasks which could be implemented to prevent, predict, eliminate or allow each of the failures.

This improvement process requires a match between the type of problems encountered and the appropriate diagnostic tools. Some of the methodologies available include:

Reliability centered maintenance (RCM) – can be used when there are production, quality, safety or environmental issues associated with the whole asset and not with a particular failing component or if there is a need to reduce production costs.

Root cause failure analysis (RCFA) – can be used when there are one or more recurring failures that cause relevant, cumulative equipment downtime. This is also helpful when there is little or no clue of what's causing the shutdowns and when the causes of failure may be due to human error.

Reverse RCM – can be useful if there are evident symptoms of a failure but its nature is not known; examples include a quality defect, spontaneous electrical, control trips or even a limit on speed or production level

Six Sigma or Kaizen events – are appropriate if there is excessive waste or high production costs.

Brainstorming – is extremely helpful for solving more straightforward problems which require a meeting of minds and a consensual decision about their solution.

Failure Effects and Consequences of the Failures

In some reliability methodologies (e. g., RCM, failure modes and effects analysis) it is desirable to define the effects of each of the failure modes described in the analysis in order to understand more about the failure itself and the immediate repercussions of the failure. This will help determine the consequences of the failure and to justify the proposed proactive tasks.

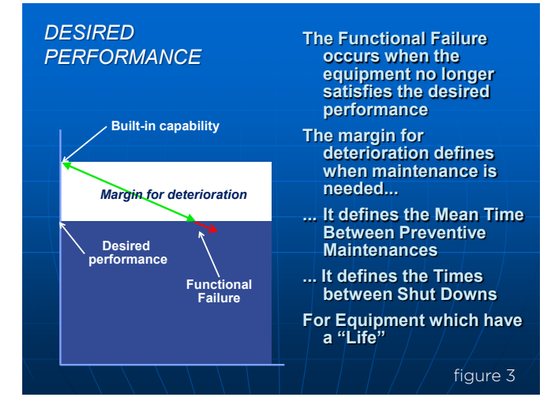

figure 3

In the majority of cases, the effects and consequences of the failures are already known; they are the reason why it was decided to carry out the reliability project in the first place. If there are safety and environmental issues involved in the analysis, the facilitator may decide to do a consequence evaluation in order to justify proactive tasks or redesigns to deal with those failure modes. In most cases, if there is a feasible, proactive task to deal with every failure mode, independently of the consequences, the analysis team will decide to include it in the program.

Proactive Tasks

The goal of all reliability initiatives is to establish proactive tasks that allow assets to be properly managed at the failure mode level. For most of the failure modes, the reliability team should define the respective operator or maintenance task as well as their corresponding operating or maintenance procedure for each of the failures defined.

There may be good reasons why we wouldn't be able to find a suitable proactive task. We are either unable to find a task that will lower business risk to an acceptable level, or we are unable to find a task that is economically feasible. Each case requires a different response. In the first case, the system will have to be redesigned to achieve an acceptable level of risk. In the second case, we can choose a run-to-failure approach for the failure mode. It is important to remember that when a run-to-failure strategy is employed, we should then put in place consequence reduction tasks to mitigate the impact of the failure. The reliability team must ensure that written procedures are in place to deal with the failure mode and that proper spares levels are maintained.

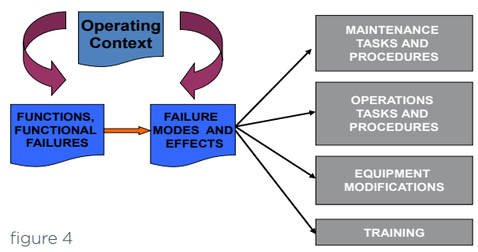

figure 4

Results and Recommendations

The final step in the analysis portion of the reliability project is to prepare the results and recommendations in the form of a presentation to the Audit Team (See Figure 4). This team includes the plant's general manager, production manager, maintenance manager, engineering manager and quality control manager. The outcomes of the reliability initiative are specified as follows:

- Maintenance proactive tasks, such as predictive (PdM) and preventive maintenance (PM), which are clearly described with the corresponding Standard Procedure, frequency and responsible party.
- Operations tasks that can be carried out by operators during their normal day-to-day activities.
- Redesigns, equipment modifications or process changes required and justified to eliminate the cause of the failure.
- For all the above cases, the training of the operators and maintainers should be included as part of the implementation process.
- Projections of anticipated costs to implement and projected benefits.

Implementation

The final step in any reliability improvement initiative is the implementation of the results and recommendations of the analysis team (See Figure 5). These include an optimized maintenance program, a training program and any proposed equipment modifications.

As mentioned before, the audit team is responsible for taking the recommendations of the reliability project to the plant and making them happen. If the project ends at the audit presentation stage and there is no implementation, then all effort is lost and the feeling of having wasted valuable time sets in.

Conclusions

By applying the steps during any reliability implementation process, we are ensured a much higher probability of success, not only from the point of view of potential financial benefits but also from the perspective of improving the plant personnel's quality of life, their safety and the preservation of the environment.

In the course of many events of asset reliability development and implementation projects, production capabilities have improved, quality issues have been resolved, and maintenance costs have been made more effective. Several millions of dollars have been saved across a great number and variety of plants.

References

- Nowlan, F.S., and H.F. Heap. 1978. Reliability-Centered Maintenance. Washington D.C. U.S. Department of Defense. Unclassified, MDA 903-75-C-0349.
- Moubray, J. 2001. Reliability-Centered Maintenance. New York. Industrial Press, Inc. ISBN: 0-831-131462.
- Bill Keeter and Doug Plucknette - 2007 The Seven Questions of Reliability Centered Maintenance Allied Reliability

Author: Jim H. Davis, VP. Performance Consulting Associates, Inc.
davis@pcaconsulting.com 770.717.2737

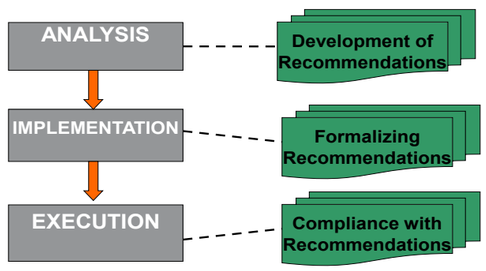

figure 5