THE OVERVIEW FOR INTEGRATED RELIABILITY CONDITION MONITORING AND MAINTENANCE OF INDUSTRIAL EQUIPMENT

1. Increasing the Existing Maintenance and Operations of Industrial Equipment Productivity in Plants

Industry sustainability, global competition and the need to maximize equipment and part lifetime reliability require the integration of condition monitoring and maintenance precision practices. This practice will allow fewer personnel to work fewer hours as well as to operate and maintain more equipment at minimum cost, while also offering higher efficiency, higher availability, higher quality and higher profits with capital equipment.

This type of trend will to increase the productivity of their existing maintenance and operations teams, maximize the reliability of equipment, while continuing to look for ways to minimize life cycle costs.

Fortunately, there are still opportunities for improvement in almost every operation, starting from design through production to facility operations with cost effective assessment technique. Industry benchmarks can help you estimate the potential in your own plant and facility.

When it comes to maintenance, operation and reliability, the use of a Benchmark or KPI should not be a “program of the month” but rather a method or technique for responsible industrial equipment, process and part improvement designed to achieve sustained levels of world-class performance. An analysis to examine how an organization is performing in such an area starts with the organization and its equipment, then addresses the basics of work order planning and scheduling, and moves on through the total organization focusing on improvement efforts and the maximization of plant equipment reliability.

The two fundamental components for success with maintenance and reliability are the people and the plant equipment. If proper input flows are provided to the production process, all properly designed equipment will produce at optimum levels of performance if the skilled and knowledgeable people are working together effectively and focused on equipment improvement. To achieve this level of success, five key elements must be core to any improvement program:

- Improving overall equipment effectiveness
- Improving maintenance efficiency and effectiveness
- Training for all employees involved
- Involving operators in the daily maintenance and upkeep of the equipment
- Early equipment management and maintenance prevention design

When these five key elements are the focus of improvement, company's experience increasingly better equipment availability, rates of performance, and rates of product quality.

They also benefit from improved safety and environmental performance and timely product deliveries to their customers.

In advanced companies, what makes these five elements so powerful is that everyone in the plant is focusing on a specific KPI: overall equipment effectiveness (O.E.E.), which in turn improves overall process effectiveness. When all benchmarking and KPI improvements are focused on improving O.E.E., the measurable improvement will be seen in:

• Equipment reliability

• Production throughput

• Controlled expenses

In this note, we believe in the essentials of component reliability monitoring, and sound cost effective industrial equipment maintenance from design, through development of part to its service operations.

On this note, it is quite necessary to analysis of the current state of the maintenance organization of industrial equipment.

2. Analysis of the current state of the maintenance organization of Industrial Equipment

2.1 The Failures of Industrial Equipment

Almost every maintenance organization sets some sort of failure elimination goal. The problem is that this goal is often set without fully understanding what a failure is. In some organizations equipment isn't considered failed unless it is totally inoperative. In others, equipment is considered failed if there is some partial loss of function such as reduced production rate or off-quality production outside their normal targets. Arguments are constantly erupting over whether or not a failure actually occurred. Eliminating failures requires a slightly different outlook on what constitutes a failure.

Let us begin by taking a look at the definition generated by Nowlan and Heap in their seminal work on Reliability-Centered Maintenance (Nowlan & Heap)

"…Without a precise definition of what condition represents a failure, there is no way to assess its consequences or to define the physical evidence for which to inspect. The term failure must, in fact, be given a far more explicit definition than "an inability to function" in order to clarify the basis of Reliability-Centered Maintenance."

"…A failure is an unsatisfactory condition. In other words, a failure is an identifiable deviation from the original condition which is unsatisfactory to a particular user."

They further define two types of failures.

"A functional failure is the inability of an item (or the equipment containing it) to meet a specified performance standard and is usually identified by an operator."

"A potential failure is an identifiable physical condition which indicates a functional failure is imminent and is usually identified by a Maintenance Technician using predictive or quantitative preventive maintenance."

Predictive or Condition-Based Maintenance is based on the concept that there is sufficient time between when the potential failure is detected and the functional failure occurs for the organization to react and prevent the functional failure. This interval is known as the p-f interval.

These definitions mean that it is up to individual organizations to decide what constitutes an unacceptable condition. This decision significantly impacts whether or not an organization will actually be able to establish failure patterns and eliminate all functional failures except for those they have decided to accept by making a run-to-failure, or no scheduled maintenance decision.

2.2 Failure Patterns

Age and reliability studies conducted on aircraft components over a period of years revealed the six basic age-reliability relationships. The vertical axis of these curves represents the conditional probability of failure, and the horizontal axis represents time in service after installation or overhaul. What is particularly striking about these curves is the very low percentage of items that display a distinct wear-out region, the large number of items that display a random failure region, and the extremely high percentage of items that display in infant failure region. Only two patterns represent six percent of the items studied display the wear-out region denoted by a rapidly increasing conditional probability of failure at the right hand end of the curve. Ninety-Five percent of the items studied had at least some region of random failures denoted by a flat region in the curve. Another Pattern curve that did not have some region of random failure. This means that 95% of the equipment in the study may benefit from some form of condition monitoring and that only 6% may benefit from time based replacement or overhaul.

It is important to recognize the significance of Infant Mortality - 68 percent of the items studied had a high conditional probability of failure immediately after installation and commissioning. The majority of item failures were being induced by activities directly related to time based replacements and overhauls. The overall maintenance strategy present at the time was extremely faulty, and was not achieving the desired goals of restoring, protecting, and preserving the function of the equipment in the safest most economical manner. At this point it highly essential to look at the maintenance activities and the operations that impact reliability and cause failures

2.3 Causes of Failures

All equipment failures are governed by the simple laws of physics present in everyday life. Friction, erosion, corrosion, stress, and impact are the physical basis for most failures. It is the interaction of humans with the equipment that determines whether these causes occur normally or abnormally.

Human interaction with the equipment occurs at every phase or operation of an items life. Substandard performance and errors at any phase will result in decreased reliability, and the result will be lower profits, more environmental incidents, and more safety incidents. In general PM activities are designed to either prevent the physical sources of failure from occurring, or removing the item before degradation caused by those forces results in loss of equipment function. As we saw from the six failure shapes, there is a very small percentage of equipment that will benefit from time based replacement or overhaul. A preventive replacement/overhaul (PM) strategy is dependent on knowing which equipment has the wear-out pattern, and what the best time is to perform the PM.

A failure elimination strategy is driven by finding those actions that create random failures, infant failures, and early wear-out failures and eliminating them. The Failure Reporting, Analysis, and Corrective Action System (FRACAS) is designed to help the organization detect common failure modes, determine the causes of the failure modes, and eliminate them. Stopping at the physical root of a failure will probably not eliminate future failures of the same type. The RCA absolutely has to address the human side of the failure equation.

2.6 Threads between Common Failures