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What constitutes adequate PM frequency in your plant? How do you know when enough is enough? Where do you want your PM program to take you? Think before answering. No guessing allowed.

When establishing an effective maintenance program, one must determine not only which preventive maintenance (PM) routines to accomplish, but how often they should be done. On the surface, the answer to this question would seem to be quite simple. Is it really?

One proven theory is that the PM to corrective maintenance (CM) work order ratio should be about 6 to 1. This theory assumes that PM inspections reveal some type of corrective work that should be completed on an asset on average every six times it is performed. The assumption is that, if the ratio is greater than 6:1, you are performing the PM too often; if the ratio is less than 6:1, you are not performing it often enough. (*The "6 to 1 Rule" was proven by John Day, Jr., manager of Engineering and Maintenance at Alumax of South Carolina, during the period when Alumax of South Carolina was certified as the first "World-Class" maintenance organization.*) You might accept this theory, put it in place in your Maintenance program and forget about reading the remainder of this article. Or, you might choose to continue reading, as we attempt to prove or disprove this theory.

How effective?

Preventive maintenance is that activity performed in some routine or regularly scheduled fashion designed to keep equipment in an existing state, prevent deterioration or failure and identify work of a corrective nature to keep equipment from causing non-productive time in any capacity. This is the detection phase of the PM investment— *the conditions that we identify and correct prior to failure are the return for this investment.*

Each PM that we develop and implement in our Maintenance organization will require some definite period of time for a Maintenance or Operations person to accomplish. How many PMs, how often, can we accomplish with our workforce, reserving a certain percentage of each day for emergencies, unplanned work and planned corrective work? Should we attempt to implement some type of control over how often we conduct PMs? You may realize, as we continue on this path, that the frequency assigned to many PMs has as much to do with effective manpower utilization as it does with discovery of potential asset problems.

All too often, our organization sees Maintenance departments being overwhelmed by the number of PMs required on a daily and weekly basis. It's not that these clients have so many PMs that all cannot be completed. It's because so many PMs must be accomplished, that there is little time allowed for emergency work and NO time for either solid corrective work to prevent emergencies (which capitalizes on the payback for our investment) or to perform other unplanned work. We also must consider the potential to "PM the equipment to DEATH!" Such a scenario—*performing more PMs than we should*—creates more problems than it solves.

The obvious question is: "How effective is your PM program?" The short answer is: "If your PM program isn't finding problems, it isn't effective."

How often?

How often should we perform any one PM procedure? It occurs to me that the frequency of performing a PM should be based on asset failure rate, or Mean Time Between Failure (MTBF) rather than on the NON-failure rate.

If I run a particular piece of equipment to failure, fix it, then run it to failure again, what is the MTBF? Knowing that number, I should be able to calculate a realistic time frame where, if I perform some routine checks and preventive measures on this asset, I have the opportunity to identify potential problems and fix them, significantly extending the MTBF. Is this not our primary goal in maintenance? More does not necessarily equal better in preventive maintenance.

Let's consider the air compressor PM that is scheduled once every month. It requires that you observe the compressor in normal operation and look for any obvious signs of potential problems, such as air leaks, knocking in cylinder areas and improper operation of the automatic drain on the accumulator. It also requires that you shut down the compressor and check the condition of the air filter and oil level.

This air compressor PM is estimated to take one hour to complete. If you accomplish it as scheduled for six months and do not note any problems, or do not have to change the air filter or replenish the oil, what can you say about this PM?

First, you have used at least five man-hours of valuable craft labor performing a PM that you did

not need to do after the first time, and the compressor was "off-line" for five hours during this PM activity. What other work could you have completed with those five man-hours?

Second, you can make a logical assumption that once per month is simply too often to schedule this PM. What to do? Should you change the PM frequency to "Annual" right away? If you did not generate a CM work order in six months, perhaps three or four months would be a good place to start. In this case, extending the length of time between PMs by a factor of 12 (to Annual) might result in missing an indicator of a potential problem and prove more costly in the long run.

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Work into the appropriate frequency carefully. If by extending the periodicity of the compressor PM to three months, you identify corrective work every fifth or sixth time you accomplish the PM, you are in the right neighborhood for an effective PM program for the compressor. If not, keep adjusting the frequency until it gives you the outcome you need for an effective, proactive PM program. Good PM work order history will point exactly to the right frequency as you continue to experiment with periodicity for the PM.

How proactive?

When first implementing a proactive preventive maintenance program, you should establish frequency of PMs with a conservative view. Many sites implement their programs using manufacturer-suggested PM frequencies which, although usually on the conservative side, are a good starting point. Adjusting the frequency of PMs as good history develops is a benchmarking exercise driven by the desire to identify deficiencies and correct them before they become emergencies—*while at the same time striving for the best possible use of your available Maintenance resource hours.*

Consider the types of maintenance actually being performed at your facility. There is *preventive, predictive, condition monitoring, corrective and emergency work* in your basket, with every type of facility and industry expending certain percentages of Maintenance resources on each type.

We've already discussed preventive maintenance to some degree.

- *Predictive maintenance (PdM)* technology uses some proven testing method, such as thermography, tribology or ultrasonics, to trend equipment performance and "predict" when certain preventive maintenance activity should be performed, thereby heading off a potential failure.
- *Condition monitoring* is the practice of closely monitoring equipment on a continuous basis to provide early detection of symptoms that could cause problems or failure, then performing some corrective actions to preclude the problem or failure.
- *Corrective maintenance (CM)* is the act of performing some repair or adjustment for a condition that was identified during the accomplishment of a PM or PdM evolution (and cannot reasonably be corrected within the allowed labor time for accomplishing the PM or PdM).

- *Emergency* work requires little definition; it is work performed in direct response to a failure that causes process downtime or imminent hazard to assets or personnel.

This is the appropriate time to note that, with the exception of emergency work, all of the other types of work are predicated on finding and fixing a problem before it becomes a "downtime" event. Perhaps we could categorize all maintenance except "emergency" under the umbrella of "*preemptive*" maintenance."

How close are you?
We have taken a "long, strange trip" around the Maintenance horn. Are we any closer to determining the proper ratio of PMs to CMs in a proactive Maintenance organization?

Two true statements that can be found in nearly every maintenance-related publication on the market are that:

1. You must evaluate the ratio of preventive maintenance actions to corrective maintenance actions to determine the effectiveness of your PM program.
2. In a proactive Maintenance environment, PM activities should account for approximately 30% of total Maintenance resource time.

The real answer could be that the ratio of PM to CM is dependent on several variables, including:

1. ***Asset criticality***—If the asset fails, what is the impact on production or safety.
2. ***Asset age***—Equipment histories will prove that most failures occur during infancy (newly installed or overhauled) and old-age (self-explanatory).
3. **Asset history**—How many times has the asset failed in the past (MTBF)? Answer the what, how, why, when and how much.
4. **Asset technology**—Do you need to PM a state-of-theart digital measuring device as often as the analog one installed next to it?
5. **Trust**—How much do you trust the asset to perform as designed when scheduled to run?

6. What percentage of your total Maintenance resources is expended on PMs? On CMs? On emergencies?
7. Can you change PM frequencies within the guidelines you have established for yourself (ref: ISO, CFR, MILSTD, etc.)?

Summing it all up

If you work through all of these exercises, you will find that the proper PM to CM ratio for the majority of your assets likely will be close to the 6:1 ratio mentioned at the beginning of this article. This is not to say that ALL PMs should be targeted for that ratio, however.

The "6 to 1 Rule" worked for John Day and Alumax, and it works for many other facilities that have chosen reliability excellence and the proven processes that come with dedication to a proactive approach to maintenance. Still, each asset in your facility must stand on its own merits. Furthermore, the proper ratio of PM to CM must be determined as a direct result of analyzing past performance and PM work order history, not a guess on the part of the Planner, Supervisor or Maintenance Manager.

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