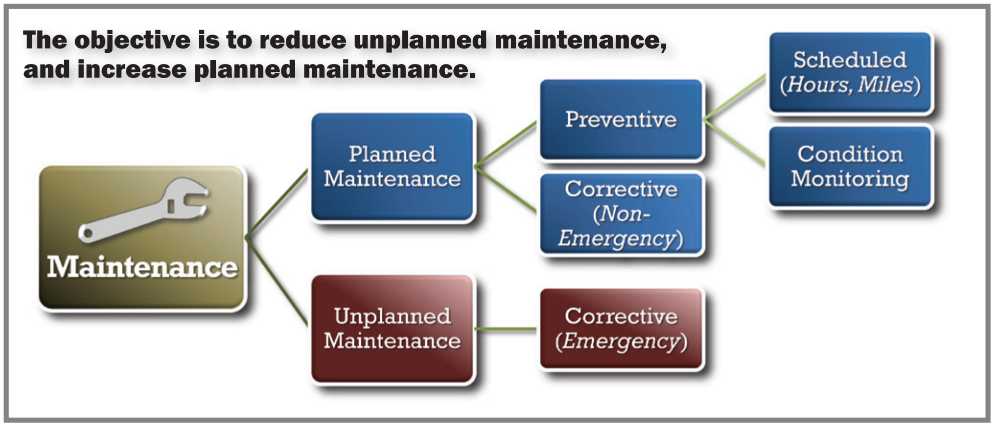
Planning Keys Effective Maintenance

By Preston Ingalls

RALEIGH, N.C. – Access difficulties can make performing routine service on oil and gas production equipment challenging, both as a result of close-proximity restrictions such as on a platform, or dispersion such as an onshore oil field where equipment can be spread over many miles.



A major objective in maintenance operations is to ensure operational capacity by reducing unplanned maintenance. Unplanned maintenance generally costs four to five times more than planned maintenance, so increasing planned maintenance tends to drive down that cost. In some cases, production lost as a result of deferring maintenance can be many times that multiplier.

The more contemporary and cost-effective approach to preventive maintenance is to do only what is needed, but no more. This requires a strategy.

Some interesting statistics bear out the need to focus on those activities that produce the most value, and to discard or de-emphasize the rest:

• 80% of preventive maintenance costs are spent on activities with a frequency 30 days or less.

• 25 to 30% of preventive maintenance is conducted at the wrong frequencies (too often or not often enough).

• 30 to 40% of preventive maintenance costs are spent on assets with negligible failure impact.

FAILURE ANALYSIS

One of the key objectives to refining preventive maintenance process is to perform only maintenance that is less costly than the failure. To help with this, we suggest using a failure mode and effects analysis (FMEA) or failure mode and effects criticality analysis (FMECA) to examine the impact of failures. FMECA takes FMEA to the next level by including a criticality analysis to determine the probability of failure modes against the severity of their consequences.

This should help to identify how detectable a failure is and how it can be spotted. If the failure can present significant consequence, the question would be, "How can the failure be detected and mitigated prior to occurring?"

Predictive maintenance methods are considered. When not available or cost-efficient, then preventive maintenance can be applied. This should include operator maintenance tasks as well.

Failure Modes and codes such as problem, cause and remedy can be established by starting with those recommended in ISO 14224 and American Petroleum Institute's Recommended Practice 689. Those should be refined with a careful examination of past failures.

Figure 1 below shows the relationship and sequence of examinations to refine the level and type of service to mitigate failures. This illustration uses SAP (systems, applications and products in data processing) as the enterprise system, but any enterprise or computerized maintenance

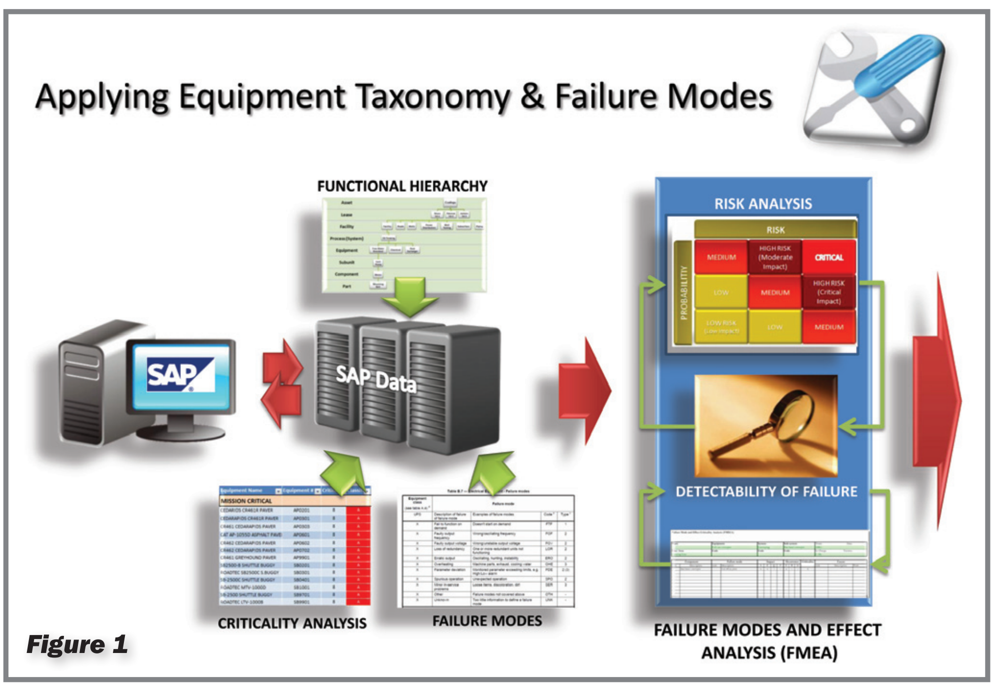


Figure 1

management system could work.

Many start by focusing on the most critical equipment first. One can identify mission critical, essential, necessary and supporting equipment based on risk. We suggest refining preventive maintenance efforts where there is the most pain. Examining failure frequencies and the accumulation of associated costs and losses can identify culprits that need attention.

DETECTION AND PREVENTION

As the P-F Curve chart (***Figure 2)*** illustrates, failures can be detected in advance by conducting an inspection. The P-F Curve illustrates the actions of equipment as it approaches failure. The curve shows that as a failure starts, the equipment component(s) deteriorates to the point that it can possibly be detected as the "potential for failure" (P point). The P Point is where the degradation can be detected.

If the failure goes undetected and is not corrected, it continues on until the failure occurs (F point). The F Point, or failure, can be losing functionality or losing the ability to perform to specification (i.e. quality). The time between P and F, commonly called the P-F interval, is the window of opportunity during which an inspection possibly can detect the pending failure and lead to corrective action.

As the chart illustrates, preventive maintenance is one of the methods that helps us to migrate away from unplanned maintenance, or emergency maintenance, by doing more preventive and condition-based Maintenance. These often lead to resulting corrective maintenance.

More powerful are those proactive and precision activities shown on the left side of the illustration. Many are systemic focuses while others are focused around ensuring reliability. These tend to be less oriented toward detection and more toward prevention.

As we move to the right following the curve downward, we see various detection methodologies. The most accurate are the predictive maintenance technologies (several are shown). Because predictive maintenance – part of the overall condition-based monitoring process – are less intrusive and is based more on applying technologies to compare against known engineering limits, it tends to be more objective.

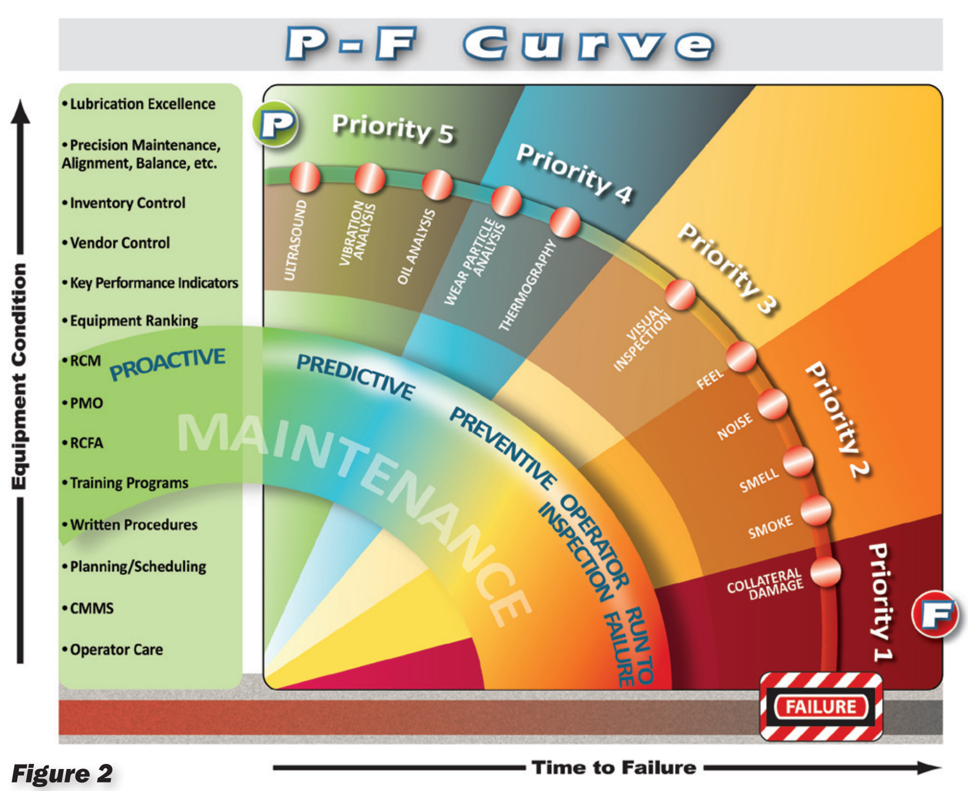


Figure 2

One then moves to the mostly visual process of scheduled preventive maintenance. Although preventive maintenance relies on the interpretation by the person performing the preventive maintenance. Therefore, it is more subjective. Despite this, there are still many opportunities to apply good preventive maintenance techniques to detect changes in conditions, since preventive maintenance includes lubrication, adjustments, limited scheduled replacements, etc.

TAILORING MAINTENANCE

Preventive Maintenance is a time-based or interval-based, planned service to detect and prevent potential failures and extend the life of equipment. We use metered hours, cycles, rotations, and units of time to schedule service. Cycles of use are far more efficient than time-based service intervals.

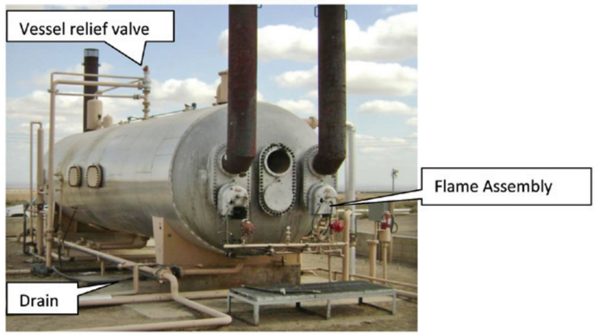
The purpose of preventive maintenance is to minimize breakdowns and excessive depreciation. In its simplest form, preventive maintenance can be compared to the service schedule for an automobile or truck. It includes activities such as lubricating, painting, testing, cleaning, adjusting, and replacing minor components, aimed at extending the life of the equipment.

The costs of operating this type of program are justified by the resulting decrease in equipment breakdowns and delayed degradation of its overall material condition. But as stated previously, traditional preventive maintenance based on original equipment manufacturer recommendations is not always affordable, may lead to overkill in tasks and frequencies.

That is why tailoring preventive maintenance by identifying probability and

Inspection Standard – TYPE 1 Operator

SCU Heater Treater



PM Title: Heater Treater	**Frequency:** Daily, Annually
Craft Type: Operator	**Developed Date:** 8/1/2009
Estimated Time: 15 minutes	**Revised Date:**
Specialty Tools:	**Safety Instructions: PPE**
PPE required: Hard hat, gloves, Safety glasses	**Document #** 141A

#	PM Task	Criteria	Yes	No	WO
	Daily	**Operator**			
	Perform energy control lock out tag out bleed off pressure	If performing work on the unit: Turn HOA to off position, Lock out panel in off position and tag. Bleed off pressure in lines before working on equipment. Open all drain valves. Wait for unit to cool before starting work. *CAUTION! PIPING IS HOT!*	☐	☐	☐
1	Inspect	Inspect fire tube for blisters or burnt areas. Slide inspection plate on burner housing and visually check.	☐	☐	☐
2	Inspect-Listen	Check for system leaks. If any occur. shut down if necessary/isolate the equipment and repair the leak(s)	☐	☐	☐
3	Look / listen	For system air leaks. If any occur. shut down if necessary/isolate the	☐	☐	☐

Figure 3

consequences makes more sense. Focusing on the components with the greatest impact from failures makes more sense than applying preventive maintenance tasks to parts and assemblies with little impact or portability of occurrence.

Using predictive maintenance is more logical because it is more accurate and less intrusive, and is able to detect changes in condition earlier on the curve. But it is not always available or cost effective. We still need some degree of preventive maintenance.

Although preventive maintenance can include cleaning, lubricating, testing and scheduled replacements, the most important task is inspection.

Inspection helps to detect early signs of changes in condition: a warning of impending failure. The key to inspection is making sure the equipment is "to specification." In other words, the equipment and its components should be in a specified state or condition, and the anomaly of it not being to spec should be stated clearly.

To make this effective, preventive maintenance procedures should state clearly as the "spec," what conditions one is looking for or not looking for. For example, merely saying "check belt" is inadequate because that leaves too much to interpretation. A better approach would be to state the conditions one wants to find the belt in, such as "free of glossing, cracks, fraying," and the amount of deflection acceptable.

MAINTENANCE TASKS

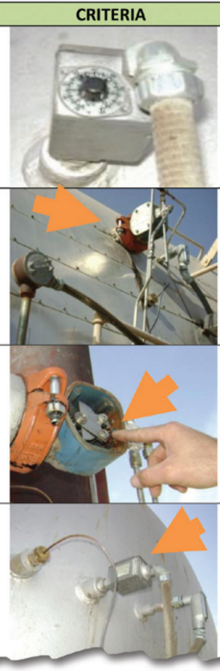
It is important to determine what preventive maintenance tasks are needed. Preventive maintenance frequencies can be altered based on deterioration and failure rates, equipment availability, the cost of performing the maintenance (labor, material and loss production), and the consequence related to asset failure.

The key to a successful preventive maintenance program is to combine it with operator inspection. Operator maintenance, called Type 1 (versus Type 2 for mechanics and technicians), is conducted during surveillance rounds (daily and weekly). Type 1 preventive maintenance can detect many potential problems through sight, sound, touch and smell. Although not as accurate as the predictive maintenance, it provides a last-stop ability to detect and correct before failure has occurred. Operators can be trained to detect many conditions as they begin to manifest themselves through physical characteristics.

According to oil field veteran Sherry Gregoire, total process coordinator for Holmes Western Oil in Taft California, "Operators are closer to the equipment than anyone else. They inherently recognize when things are not right. Given training and a structured operator care program using total process reliability or total productive maintenance, we have seen our emergencies drop down to the 4-5% range. Operators assume more ownership and care for the equipment differently."

With thirty-two years in the oil field, Gregoire is passionate about operator engagement as part of the preventive maintenance process.

Figure 3 shows part of an operator standard for a Type 1 preventive maintenance on a heater treater. Notice the safety instruction, specificity and detailed instructions for the operator to conduct the inspection. Pictorials and call-outs are used to aid the operator. We encourage using job aids and standards rather than relying on recall or text only.



Inspection Standard – TYPE 2 Technician

LOCATION	METHOD	CRITERIA	WK	2WK	M	YR	TIME	WHO
	Turn dial setting clockwise to a hi temp position to turn off the flame				X		1 min	Technician
Test Low level shut down (Section A)	Test to ensure proper operation				X		3 min	Technician
	Remove plate and trip float				X		3 min	Technician
Test Hi Temp Shut off switch (Section B)	Test Hi temp shut down Test to ensure proper operation. Expose dial setting by [illegible] the				X		2 min	Technician

Figure 4

Figure 4 above shows the Type 2 preventive maintenance on the same unit for technicians to perform at a monthly interval.

Over-maintaining equipment does not leave much evidence of wasted effort. In fact, we often feel secure in the knowledge that we are doing a great job of maintaining our assets through frequent preventive maintenance. The problem is, we are wasting valuable resources, and in the case with much preventive maintenance, we are shutting down the equipment unnecessarily.

PERFORMANCE INDICATORS

In refining a preventive maintenance program, the key is to start with the most problematic equipment. It also means having good metrics to measure the effectiveness and results of your preventive maintenance efforts. Example metrics or key performance indicators include:

- Preventive maintenance as a percentage of total maintenance hours;
- Percentage of compliance with preventive maintenance schedule;
- Mean time between failures on critical equipment;
- Percentage of preventive maintenance review (revised preventive maintenance);
- Percentage of corrective maintenance from preventive maintenance; and
- Ratio of preventive-to-corrective maintenance.

Reliable equipment is critical to every oil and gas operation. Ensuring that the correct tasks are done well and on time can prevent losses, both in equipment and job delays.

In the words of Shigeo Shingo, "The most dangerous kind of waste is the waste we do not recognize."

Preston Ingalls, president and CEO of TBR Strategies, in Raleigh, N.C. He has over 39 years of experience leading maintenance and reliability improvement efforts across 27 countries for Royal Dutch Shell, Occidental Petroleum, Hess, Key Energy, Bayer, Baxter Healthcare, Lockheed Martin, Mobil Chemical, Unilever, Monsanto, Aera Energy, Pillsbury, Corning, and Texas Instruments. For the past 10 years, he has consulted extensively with oil and gas, and highway construction companies. He holds two undergraduate degrees in engineering, as well as a master's degree in organizational development.