Plant Operations, Maintenance and Reliability

Maximize benefits with robust maintenance planning and scheduling

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Effective routine maintenance begins with effective leadership. Leadership requirements for a robust routine maintenance program include some high-level deliverables:

- Integrating, implementing and actively supporting maintenance and reliability strategies within each organization
- Establishing clear goals, objectives and metrics
- Communicating effectively
- Modeling positive maintenance and reliability behavior
- Selecting and placing sufficient, qualified personnel
- Providing initial and on-going training, including competency evaluations
- Facilitating professional development
- Linking safety, maintenance and reliability performance to incentive rewards.

Apply rigor to planning and scheduling. For three decades, many companies have realized significant benefits by successfully implementing robust routine maintenance planning and scheduling processes. Most of this success can be attributed to a clear understanding and application of both activities. Planning is the "what and the how" and requires the planner to visit the worksite, whereas scheduling is the "who and the when" and can generally be carried out remotely.

Many organizations use maintenance planners and schedulers in their routine maintenance work processes to lighten the burdens of the frontline supervisor, as well as the craft-persons, which allows them to be safer and more efficient.

It is the responsibility of the planners to visit job sites so they can properly identify the materials, tools and procedures needed to perform a proper maintenance task and estimate the craft and time required to complete each step. The scheduler is responsible for coordinating with operations to properly schedule repairs to align with operational needs and skills availability.

When organizations combine these two tasks into a single role (i.e., a planner/scheduler role), the results are often unsatisfactory. This person seldom gets to the field to properly plan the job and order the correct materials. As a result, the planner/scheduler often spends valuable time changing the schedule to correct for the poorly made plans and missing/incorrect materials and procedures.

It is recommended to keep the two tasks separate. If an organization has a small maintenance team (company and contractors) that can only justify one position for both planning and scheduling, that practice will only be successful if a well-disciplined individual can separate their time spent in the field for planning and office time for scheduling. Unfortunately, the natural conveniences will entice the individual to spend more time in the comfortable office and less time in the field (hot, cold, rain, snow) completing proper work plans and bills of materials for the work.

Few computerized maintenance management systems (CMMSs) are configured to support effective scheduling. While such systems serve as an effective communications tool, they are not designed properly for scheduling functions. CMMS vendors have yet to develop a solution that provides a management window to observe the schedule loading by craft by day. Consequently, seasoned practitioners have created a work-around by downloading the backlog and building the schedule using Excel (or similar) programs and sorting by day/craft.

The successful and thorough application of planning and scheduling processes depends a great deal on the amount of work these key individuals can perform on a week-to-week basis. As a rule, the ratio of planner to technician is 1:12 (maximum), and the ratio of scheduler to technician is 1:40 (maximum).

Process safety management (PSM). Proper routine maintenance is a critical component of effective PSM, which aims to prevent hazardous incidents in industries that deal with chemicals, oil, gas and other dangerous materials. Routine maintenance plays a crucial role in ensuring a safe and efficient work environment and ensures that equipment and processes are operating as intended, reducing the risk of unexpected failures that can lead to accidents or hazardous incidents. Regular inspections, repairs and replacements of equipment parts prevent minor issues from escalating into major hazards. For instance, a small leak in a process facility, if not promptly addressed, could lead to a major release of toxic substances.

All process industries are governed by strict safety regulations and standards that are designed to protect workers, the environment and the public—regular maintenance helps ensure compliance with these regulations. Failure to maintain equipment not only endangers lives but also exposes the company to legal liabilities and financial penalties.

Equipment basic care and housekeeping. Best practice is when operators perform basic care and condition monitoring activities. These knowledgeable and well-trained individuals understand the value of preventing and predicting equipment failure where they perform or assist in most routine maintenance activities. Additional training with support from maintenance and reliability personnel is typically required to make this successful.

Equipment and systems will operate with higher reliability if they receive frequent basic care and thorough housekeeping. Neglected equipment will often perform less reliably. The routine practice of general equipment basic care and housekeeping is a staple of best-in-class companies and facilities in maintaining reliable operations over the lifecycle of equipment. Facility reliability and maintenance strategies should include a robust plan for field accountability for equipment care and facility housekeeping. **Note:** One of the advantages of housekeeping is creating ease in field observation of when conditions change for a piece of equipment, whether dynamic or stationary.

Ensuring the quality of maintenance execution. The quality of maintenance execution ensures that maintenance activities are performed to meet or exceed standards and specifications. Higher-quality maintenance work equates to improved equipment reliability and less frequent rework, which in turn directly affects maintenance spending. Key elements of quality maintenance execution include:

- Specifications or procedures for repair
- Robust planning and scheduling
- Quality of materials
- Quality of repair work (e.g., staff, contractor, outside shop)
- Proper inspection and testing
- Good housekeeping
- Proper records documentation
- Cause of failure analysis.

Routine corrective, reliability-based and preventive maintenance (PM) should be completed with quality as the basis. Quality repairs ensure that equipment is returned to service and performs per design (**FIG. 1**).

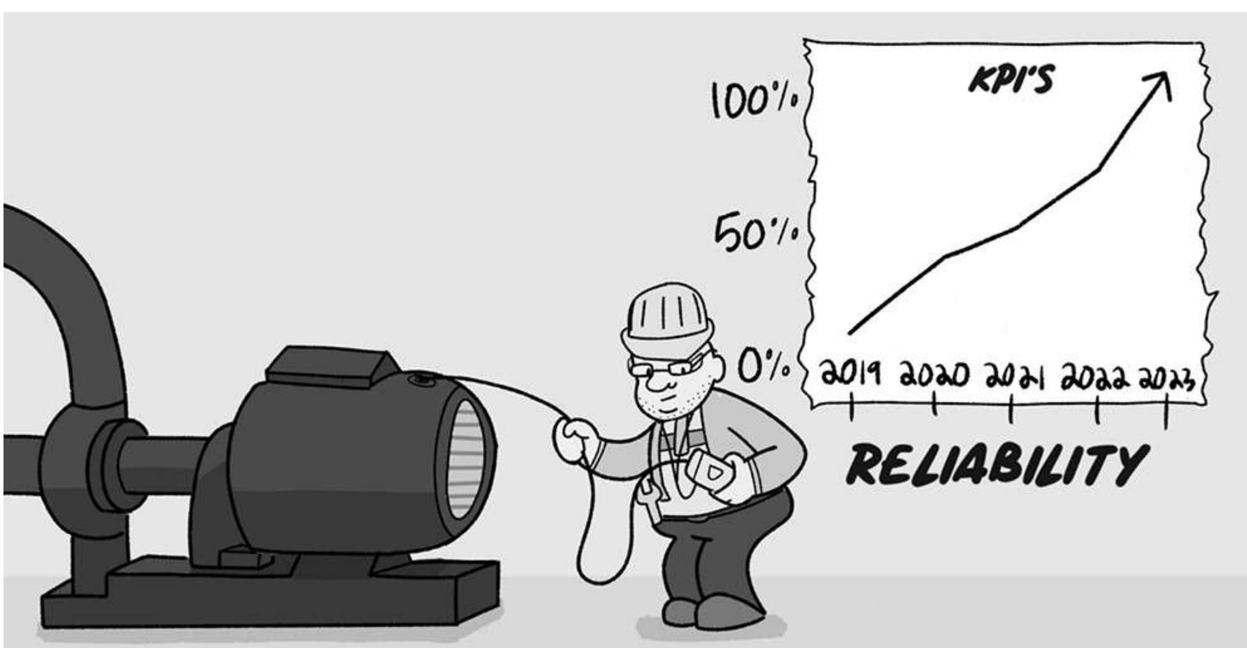

FIG. 1. Equipment and systems will operate with higher reliability if they receive frequent basic care and thorough housekeeping. Source: Roman Tingle.

PM, predictive maintenance (PdM) and risk-based inspection (RBI) programs. The proper execution of PM, PdM and RBI will minimize integrity and production risks. Results analyses will allow the optimization of the frequency and application of tasks, and continuously improve the baseline reliability and maintenance program—this maximizes maintenance cost effectiveness, as well as availability and reduced associated production impacts. Additional analyses of unexpected equipment failures will allow further improvement or the addition of PM, PdM or RBI, where it was inadequate.

These programs should also be continually analyzed and optimized by the appropriate facility personnel. This is a core role of a reliability engineer or technician for PM and PdM and an engineer or inspector for inspection results. The results of PdM, PM and inspections should be evaluated for future frequencies, particularly if there are multiple PdM or inspection readings without significant change or multiple PM activities with no problems found or calibration changes required. In these cases, it may be prudent to increase intervals—with proper management of change (MoC) evaluation—provided none of these are regulatory-driven (significant history is usually required to merit occasional exceptions to regulations).

Conversely, where unanticipated failures have occurred [corrective maintenance work orders written against failures that have unacceptable health, safety, security and environment (HSSE), production losses or high maintenance costs], the frequency or type of PdM, PM and inspections may require re-evaluation. This will enable the detection of the type of failure mode and the cause, or indicate that the inspections must be completed on a higher frequency. If a program is in place, the investigation should consider a potential breakdown in the system from intended detection to intervention, as this may be systemic. This will reduce other similar types of failures.

Performance management. "What gets measured, gets managed" remains a true statement for routine maintenance. Establishing the proper metrics that monitor the roles/products of planners, schedulers, operators, technicians and engineers—as well as reviewing the quality of their deliveries—is a key responsibility of the owner of the routine maintenance program. The effective monitoring of these indicators, including timely interventions, will drive the desired performance.

Successful RM programs select a good mix of work processes metrics and results metrics, as shown in **TABLE 1.** Most programs focus solely on the results, which are often impacted by external factors. However, focusing on work processes will drive the desired outcomes if those processes are properly designed and managed.

TABLE 1. Routine maintenance metrics

Metric name	Basic	Best	Details
% safety critical equipment (SCE) overdue work orders	0	0	Total number of open work orders per month, excluding tasks [i.e., not canceled (CAN), closed (CLOSE) or pending closure (COMP), (WCLOSE), (PCLOSE)], have the safety critical flag checked and have the target finish date within the month
Work order compliance	85%	> 95%	Number of work orders completed by target date/total number of work orders
Work hour schedule compliance	> 70%	> 90%	Total number of actual hours on work orders that moved through transition WSCHD to ISSUED where the work order is closed or completed (status COMP, WCLOSE, PCLOSE or CLOSE)
Production critical equipment mean time to repair (MTTR)	Equipment specific	Equipment specific	MTTR (by equipment type): Metric highlights long duration downtime due to inefficient permitting, repairs, availability of parts, poor planning or preparation, etc.
Emergency maintenance	< 10%	< 5%	% emergency work hours/Total maintenance work hours
Estimated to actual maintenance work hours	within 30%	within 10%	Actual vs. estimated work hours as recorded on work orders
Maintenance personnel utilization	> 45%	> 70%	% value-added time vs. time available: includes safety talks, job safety analyses (JSAs), isolations, de-isolations, failure mode and effect analyses (FMEAs), root cause failure analyses (RCFAs), closing work orders, etc.
% planned work	80%	95%	(Number of planned work hours* / total number of work hours) x 100% (* including PdM and CM work hours)
Schedule loading	90%	100%	By day and by craft to evaluate scheduler performance
% equipment prepared and ready for maintenance	90%	100%	% of time operators have equipment prepared for maintenance on schedule (e.g., isolations, bleeding, purging)
% operator surveillance rounds completed	95%	100%	% of operator rounds completed, including condition-based surveillance duties (e.g., vibration, temperature, pressure)
Work hour backlog	Instrument and electrical (I&E): 80 hr per tech;	I&E: 40 hr per tech	Monitoring backlog is used to determine workforce efficiency and utilization, backlog cleansing requirements
	Mech: 160 hr per tech;	Mech: 120 hr per tech	Staffing adjustments
	Static: 240 hr per tech	Static: 160 hr per tech	
Rework	< 5%	< 2%	% of reworked tasks within one month of completing work order; metric provides feedback on quality of maintenance tasks, materials, etc., and may indicate flaws in the systems that must be addressed
PM/PdM vs. corrective maintenance	> 50%	> 75%	% of PM/PdM vs. all maintenance activities; metric provides a view of the proactiveness of the maintenance program
Critical equipment/ PM/PdM ratio	> 70%	> 90%	% of PM and PdM tasks for safety and production critical equipment vs. all equipment; metric provides an estimate of whether maintenance tasks are being applied against the equipment with the most risk to HSSE and production

The authors' company offers expertise and significant hands-on experience and knowledge to support the implementation of effective routine maintenance programs. **HP**

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