Declaration of Rory Swezey

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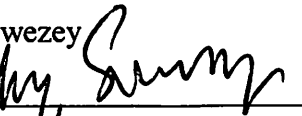
Signature: 

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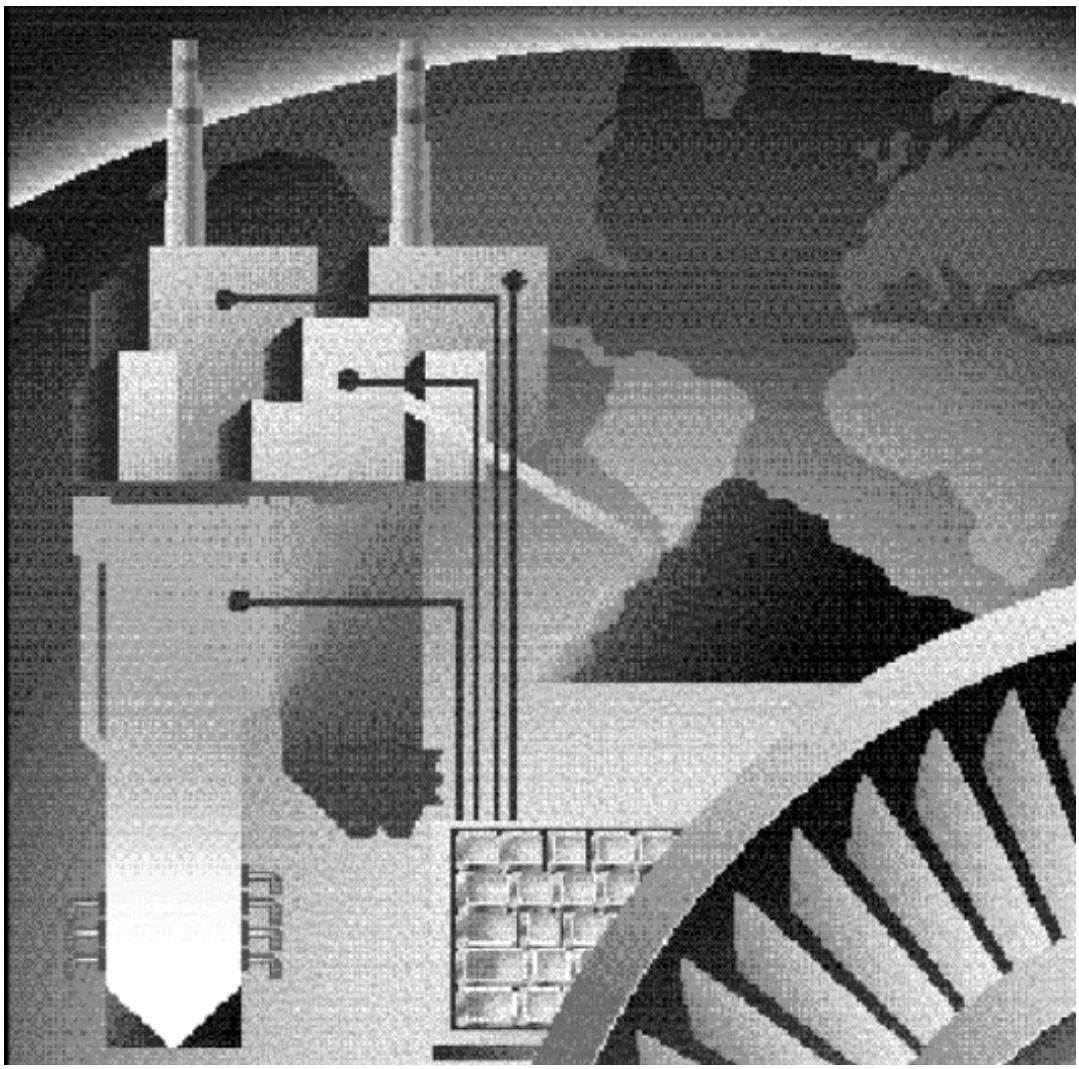
EXHIBIT A

EPRI

Best Practice Guideline for Maintenance Planning and Scheduling

Technical Report



Best Practice Guideline for Maintenance Planning and Scheduling

1000320

Final Report, December 2000

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REPORT SUMMARY

Planning and scheduling of maintenance work is important to the efficient day to day maintenance of equipment at fossil power plants. This guideline, based on collective experience from several EPRI projects, provides best practice guidelines for maintenance planning and scheduling.

Background

Planning is a process of determining resources required on future maintenance work. This includes estimating labor, materials and tools on future jobs. Better planning leads to fewer breakdowns. Scheduling is a process of setting the start time and duration for future maintenance work that allows an orderly progression of allocating labor, material and tools so that the work fits into the plant production schedule. As scheduling improves, jobs are identified many weeks before they are executed, and completed predictably. As the planning and scheduling processes improve over time, the backlog of maintenance work decreases, and people have the time to do preventative and predictive maintenance. Unfortunately, many fossil power plant organizations do not have and often do not want effective planning and scheduling processes. Without management leadership, maintenance organizations tend to slip into a reactive maintenance state where most of their work is fixing equipment that breaks. This creates a downward spiral of increasing work backlog, reduced equipment reliability, and higher maintenance costs.

Objectives

- To optimize the utilization of power plant resources by establishing and improving planning and scheduling work processes
- To describe the best planning and scheduling practices in the industry and the spectrum of actual planning and scheduling practices observed at fossil power plants, including a description of the process steps performed, people's roles and responsibilities, and the technologies that support those processes
- To outline the process for establishing and improving planning and scheduling practices in fossil power plants, including consideration of typical organization resistance issues, getting management buy-in, changing people's behavior, keeping the process running, and improving the processes over time
- To list the metrics that measure how well planning and scheduling are done and how they are improving over time, including typical performance levels of actual organizations and goals for achieving best practices.

Approach
Drawing on experienced gained during earlier EPRI work on maintenance practices, the project team developed guidelines on best practices in maintenance planning and scheduling.

Results
Planning and scheduling are established and improved by following a proven process that includes determining business goals, assessing current conditions, addressing work culture issues, implementing changes, and reinforcing changes over time. Some business goals that can be achieved through adequate planning and scheduling are lower maintenance cost, improved reliability and commercial availability, lower staff levels, and increased production levels. Improvements are needed if an assessment of current conditions indicates there is a large growing backlog or if most maintenance resources are spent fixing problems. Some work culture issues that may need to be addressed are communication, accountability, or resistance to change.

EPRI Perspective
Establishing and improving planning and scheduling requires a change in people's behavior and the work culture. This improvement requires substantial internal effort, time, and money. Experience has shown that management commitment as well as coaching from an outside expert is keys to a successful effort. Internal programs and programs without strong management support take longer and do not achieve the same level of success.

This report is part of EPRI's development efforts under the Plant Maintenance Optimization (PMO) Target, number 62 in 2000. The PMO mission is to lead the industry by developing and demonstrating products and services that will improve use of power plant maintenance resources and increase profitability for generation businesses.

Some case study reports that describe EPRI projects where planning and scheduling were improved include *Maintenance Work Management Improvement: Improving Culture and Work Process, 1998* (TR-109734) and *Maintenance Optimization Project at Merom*, *1999* (TR-111897, V1 & V2). Other related EPRI reports are *Maintenance Work Management Best Practices Guidelines: Maintenance Assessment and Improvement*, *1998* (TR-109968); *Maintenance Work Management Practices Assessment*, *1997* (TR-106430); *Plant Maintenance Optimization, 1997* (TB-108949-R1); and *Value-Based Maintenance Grid for Assessing Work Management, 1999* (TR-108937).

Keywords
Maintenance
Maintenance planning

EXECUTIVE SUMMARY

With the resources at power plants streamlined to the essential, utilization of those resources must be efficient and effective in getting work accomplished. Inefficient utilization of the limited resources will lead to higher costs of getting work done, growing backlogs, and inability to care for all the critical equipment of the plant. There exists at plants where resources are streamlined that the organization may find itself at the precipice of a downward collapsing spiral where failures on equipment may start occurring faster than they can be prevented or faster than the equipment can be repaired. The resources provided by management to maintain the assets of the plant must be efficiently and effectively used in a disciplined program of planned and scheduled activities. By eliminating inefficient activities and providing all external needs of the worker, huge increases in workforce productivity can be realized. Not only is providing for all of the external needs imperative, the sequencing of work activities necessary to assure all priority activities are accomplished at the optimum times. The failure defense strategy of a Preventive Maintenance (PM) program cannot be compromised. The investment made in the plant resources must pay off and provide a return on investment according to the efficient completion of sequenced priority work.

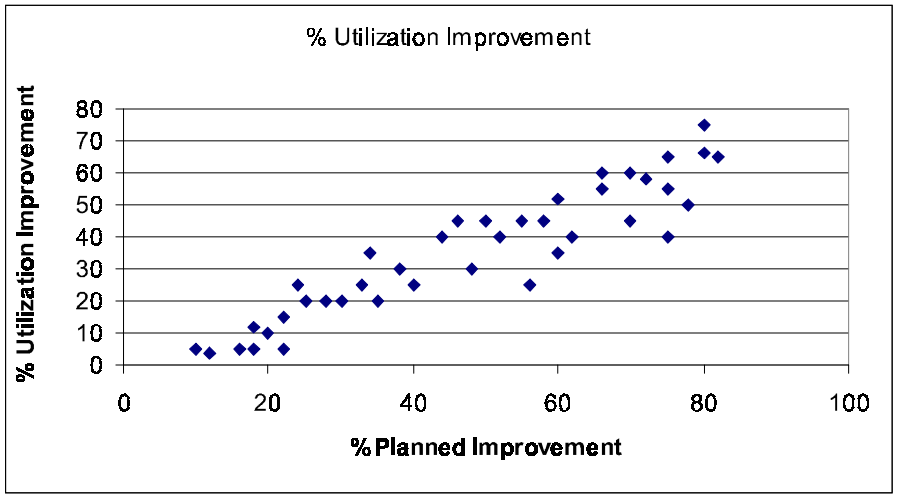


Figure 1
Increase Labor Utilization by Planning More Work

This Figure 1 contains data collected from interviews with maintenance managers of organizations who implemented improved planning and scheduling processes. The chart simply shows that when more work is planned, the equivalent utilization of plant resources increases significantly. For example, if the work process achieves a 40% increase in work planned, an

increase of 20-40% on utilization should occur. If the organization has 40 maintenance workers, a 20% increase in utilization yields an equivalent worker increase of 8 persons.

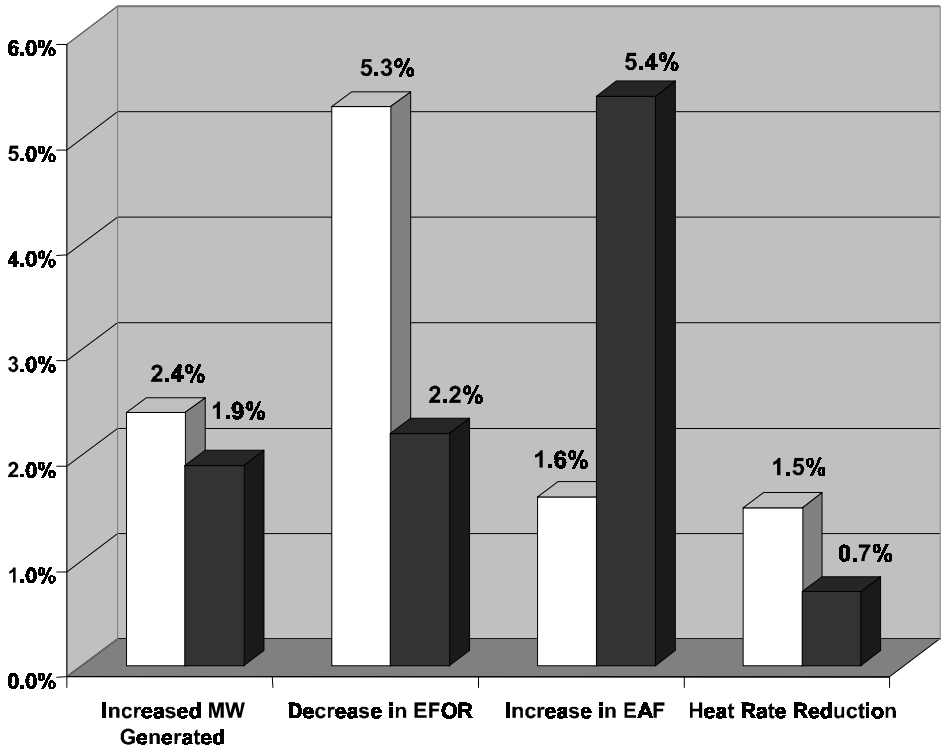


Figure 2
Data from Two Midwest Utilities Who Improved Planning and Scheduling

This Figure 2 indicates other types of improvements achieved by plants at two Midwest utilities that improved planning and scheduling in an EPRI project. These improvements, as well as others such as reduced overtime and contractor usage, led to several million dollars in bottom-line savings for each plant.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1
INTRODUCTION

Planning and Scheduling is a critical part of the big picture of Plant Maintenance Optimization (PMO). In simple terms PMO is moving the maintenance program from a “reactive” philosophy were maintenance is performed as a result of unexpected failures, to a “planned” approach were maintenance is performed at the most optimum time and often times before equipment failure. Reactive maintenance is more costly and has a negative impact on plant availability, while PMO is more economical and significantly improves plant availability. PMO also optimizes the existing planned maintenance activities at a plant. PMO answers four basic questions. What will a plant do differently in its maintenance program? How will a plant carry out the specific maintenance tasks? Who will do the work? What advance tools are available to do the maintenance work?

For a successful PMO program the following needs to be addresses:

- Advanced Maintenance Strategies: These strategies address what maintenance approaches will be taken to move the maintenance program from reactive to planned. Such approaches include, optimizing the maintenance basis, implementing predictive maintenance program and developing a living proactive maintenance program.
- Work Process: This part of the PMO process addresses the how maintenance is accomplished. It examines the work process from work initiation, to planning and scheduling, to work execution, to work completion and finally to continuos improvement. Note the Planning and Scheduling elements fit into PMO at this Work Process level.
- People: Skills, Work Culture, Management: For maintenance optimization to be successful it requires a well-trained work force, good management and an organizational structure. A work culture that is respective to new ideas. This aspect of the PMO approach focuses on who does the work.
- Tools/Technologies: This category of PMO focuses on the tools required to support the staff. The technology level covers all technical advances such as: automation, condition monitoring, computerized maintenance management systems, and distributed control systems. There have been significant advancements in technologies, which can help an organization meet its availability and budget goal.

2
DEFINITIONS

Planning

So what is planning? Simply put, it is the “What” and “How” of getting work done. What is the problem and how are we going to fix it? The primary concept behind planning is to remove as many obstacles to smooth job accomplishment as possible, prior to starting the job. The payoff to this approach is significant in terms of reduced maintenance expenses and increased uptime for the production equipment. It has been proven that the labor invested in planning maintenance jobs pays for itself several times over in terms of increased productivity by the craftspeople. The bottom line impact of planning and scheduling is less overtime pay, a reduction in contractor use and allowing attrition to occur without having to replace craftspeople.

There are several elements to the maintenance planning process. It is preceded of course with the identification of a work need that is then communicated and given a priority. Planning then starts with a clarification of the job’s priority through the joint prioritization process. This serves to give the planner direction on which order to plan the work. Operations may be exerting more influence on what gets planned at this point in the work management process because they understand how the problem is affecting production output. Maintenance, on the other hand, has the responsibility to communicate back the logistics of getting the problem repaired, but since the planning is not yet complete, maintenance can only respond with the knowledge gained from past experience.

With the planning process off and running, the planner must first evaluate the depth of planning required for each job. This should involve an inspection of the job site in person for all but the simplest of jobs. A checklist of items to consider is useful when performing field scoping so that nothing gets overlooked. The list of things to consider includes: tools, materials, safety concerns, permitting, maintenance equipment and crafts required. While in the field, the planner can begin roughing out the job steps that will be required to complete the repair. This serves as a valuable mental exercise to help ensure nothing has been overlooked. Remember that the name of the game is to anticipate obstacles and remove them through preparation.

Now that the planner has a thorough understanding of the problem and how to make the repair, he/she has to capture this knowledge in writing so that it can be used to keep the backlog accurate and more importantly, inform the craftspeople what they need to do. A job package should be assembled that is consistent from one job to another. Craftspeople can rely on getting similar information presented in the same format from job to job. This breeds familiarity and improves efficiency. The job package should contain job steps, material list, labor estimates, cost estimates, drawings and other equipment documents.

A big part of planning is coordination with other departments. The planner will have to work with operations, purchasing, the warehouse, engineering, inspection, safety, contractors and other craft planners to achieve the objective of removing obstacles for the craftspeople. Much of this coordination is best described as investigative planning. Without a definitive start date for the job the planner may only be able to obtain estimates for the many elements of the job plan. Planning coordination is definitely a recursive activity, requiring several iterations of inquiries to other departments. This helps to define the primary role of the planner, to act as the focal point in getting a job ready to be worked.

Does this sound like a lot of work? It can be, and initially there is a learning curve to overcome, but with experience and some indispensable planning tools such as standard job plans, bills of materials (BOMs) and labor estimating standards, the planning process will pay big dividends. Besides the real results from industry, common sense tells us planning is worthwhile. Therefore, once you make the investment into the key step in the work management process, you must have the internal fortitude to stick with it.

Finally, not every job has to be planned to the nth degree. Stay focused on the objective of work planning-to minimize production equipment downtime through anticipating and mitigating obstacles to getting the work done. Let this be your guide to which jobs get planned thoroughly and which jobs get minimal planning in the form of labor estimates
(this is required for all jobs to keep the backlog accurate).

Scheduling

Following our definition of Work Planning (the “What” and “How”), Work Scheduling then is the “Who” and “When” of getting work done. In this step of the work management process the objective is to choose the work to be done, finalize the coordination of resources, and most importantly, commit to get the work done by a specific date. This is where the joint prioritization process is most active. The commitment to a date is primarily between operations
(who understands the need) and maintenance (who understands the logistics/feasibility). Other departments, such as engineering and production planning, may also have involvement in making the commitment.

The key resource that drives when a job gets scheduled is the “who”, in other words, manpower. If manpower availability is the driver for when work will get done, it follows that the organization must keep track of this valuable resource. Tracking manpower availability should be done for a rolling six-month period at a minimum. It should be tracked by individual craftsperson and adjusted for known events such as: vacations, holidays, training, meetings, etcetera.

With the manpower availability known, work can be scheduled up to that level. This is of course, done by each craft type-mechanical, electrical, instrument, et cetera. The challenge in scheduling is to narrow the list of jobs in the backlog from everything down to just what you want to get done tomorrow. This is best managed by first scheduling jobs into weekly buckets for the next three or more weeks. The further out into the future you go with weekly scheduling, the smaller the commitment will logically be. But weekly scheduling allows the organization to build on its commitment by starting with just a few jobs in the third week out and adding to the

schedule as the weeks progress. By the time you are scheduling for next week, you may be committing to enough work to utilize 80% of your available manpower in that week.

During work planning, the coordination activities were described as investigative. Now, during work scheduling, it is time to nail down the coordination of all the resources that will be required. This will in large part determine whether a job can be scheduled (committed to) as intended and ultimately whether the job will be accomplished according to the job plan. Much of this coordination will take place by the scheduler in putting a draft of the schedule together; it can be finalized during the scheduling meeting with all departments that are involved.

The weekly schedules feed a daily work schedule that is prepared a work shift or more in advance. Again the key resource for daily scheduling is manpower; there must be an accurate record of who will be available and for how many hours tomorrow. Daily scheduling is done at 100% of the available manpower. This is necessary if the organization is to accurately measure its level of commitment to the schedule. Another reason for scheduling at 100% is to introduce some resistance into changing the schedule. This isn't to say that you can't accommodate emergency work, it happens and you have to deal with it, but if it is not an emergency then resist the temptation to squeeze it in.

Committing to the work on a schedule implies that everyone involved in that commitment (primarily operations and maintenance) will do everything within their control to complete the work as scheduled. This is the fundamental concept behind scheduling. This says that operations will honor their commitment by making production equipment available per the schedule, they will make it accessible, have it cleaned, cooled down and ready to be worked on. For maintenance this says that they will show up per schedule, make quality repairs and return the production equipment on time and have the work site cleaned up.

With the completion of the scheduling step in the work management process, the organization will have achieved setting up for the right work, at the right time and with the right resources. The work accomplishment step is where this will be realized.

Backlog

The backlog includes all jobs, regardless of status, that have been identified, but are not yet complete. Thus, a job enters the backlog following work order approval and is removed only after the work is complete or it is deleted, for whatever reason. This definition of backlog includes repair work as well as preventive tasks. It includes work in the formal work order system as well as the lists kept in control rooms or in engineer's offices. It includes routine, daily work as well as work to be done during an overhaul or turnaround. It includes maintenance work as well as capital project work that will utilize plant craftspeople. **Backlog is all uncompleted maintenance work.** Thus, for effective management purposes, all of this work should be captured in one place, ideally a Computerized Maintenance Management System (CMMS); a powerful relational database tool that allows work data to be organized in the best manner to meet the organization's needs.

Think of the backlog as the fuel supply for the Work Management Process. Just like the fuel for a power plant, it must be managed and cared for. Managing the backlog means using the

backlog daily as a tool to make decisions, decisions about what to plan, what to schedule, how many craftspeople are needed, when to take equipment out of service, when to use contractors, when to schedule vacations, et cetera. Caring for the backlog means ensuring that every job is accurate, accuracy of job information, job plans and labor estimates, status coding and routing. Caring for the backlog also means promptly removing jobs when they're completed.

3
SPECTRUM OF PLANNING AND SCHEDULING PRACTICES

Many facilities believe that they already plan and schedule. In fact, very few have fully implemented these processes, but they may have selected portions of them to implement. This accounts for the varying degrees of success that operations have in this area. This section provides descriptions of typical states from nearly completely reactive maintenance to a fully planned and scheduled system.

Reactive Maintenance, or the Tasmanian Devil

In this state, virtually no planning or scheduling is done. Like the cartoon Tasmanian Devil, maintenance employees spin out of control from one job to next. There is no agreement between Maintenance and Operations as to what work will be done. When corrective work is identified by Operations, it is generally requested on an immediate basis. There is no faith that work which is placed in the backlog will be done later because more urgent requests are continually being made. Craftspeople are given work orders and sent to the job site without materials or expectations for how long the job will take. Their first stop is at the Control Room where they wait (sometimes more than an hour when the shift starts) for the operators to clear the equipment. Then, they will go to the job site to scope the job.

When they decide what materials they need, they go to the Warehouse to get the parts from stock. Naturally, the parts required may or may not be there, depending on what is in stock and inventory accuracy. In these days of inventory reduction, it is less likely that a craftsperson can go to the stores window and expect to find all the parts they need to complete a job. Cost benefits from decreased inventory can easily be frittered away by needless parts expedition charges.

In the event that work can proceed on this job, the crew may get the work partly completed before they are called to an urgent job on another piece of equipment. They must leave the job they are on with the equipment out of service or quickly patch it before they move to the next job.

Obviously this way of getting work done is frustrating to all involved. Like Taz, employees are angry, upset and mouth frothing. The results are lost time, lost productivity, high costs, low morale, excess downtime, reduced accountability and unhappy customers.

Day-Ahead Planning and Scheduling, or Mr. McGoo

In this scenario, (the one most commonly found in today's generating stations) either planners or 1st Line Supervisors are looking ahead one day. They decide what jobs they want to get done the next day by looking at the backlog or from requests they have received from Operations. They may make a list of jobs that they want to accomplish, but it is unlikely that this list is agreed upon with Operations or communicated in advance. Certain pre-planned activities may be accomplished, such as overnight clearances, but this is not done consistently. They may or may not look into materials requirements. Unfortunately, like Mr. McGoo, they barely see past the end of their noses. They may be looking forward, but they can't see far enough to be effective. In essence, sites in this state may avoid some of the pitfalls of a completely reactive system, but they are still inconsistent enough that the benefits of their limited planning and scheduling are not readily apparent.

The Weekly Wish List, or Wile E. Coyote

Some organizations progress to this next level of planning and scheduling. Like Wile E. Coyote of Roadrunner fame, they likely believe that their planning and scheduling is effective because they put a lot of effort into it and have some limited success in the beginning stages. Some level of planning is done on most jobs. A labor estimate is placed on many work orders and some coordination with internal and external groups is done. The salient quality of this stage is the weekly schedule. Many sites believe they have implemented long range scheduling because they have a schedule that looks one week ahead. Typically, though this schedule still includes jobs that have not been planned to the point that they are truly ready to be done. Generally, a planner has still prepared the schedule without the formal input of Operations and Engineering. In addition, these schedules rarely look beyond one week into the future.

Most salient though, is that labor estimates are not usually balanced against available resources. Jobs are placed on the schedule without a notion of the true maintenance labor availability for the following week. Without this labor balancing, the schedule is truly a "wish list" of items that the maintenance department would like to get done, but not a firm schedule. Crews are either underscheduled or overscheduled. Regardless, neither Maintenance nor Operations has any real faith that the scheduled jobs will get done. Unfortunately, like the egotistical Wile E. Coyote, who refers to himself as a "Supergenius" on his business cards, these are the organizations that are the most difficult to change, as they believe they are already performing at accelerated level.

Best Practices Planning and Scheduling

Why isn't there a cartoon character to illustrate this section? Because real planning and scheduling isn't a game or a cartoon. It's hard work. Moreover, when these processes aren't functioning and equipment fails, the results are real and costly. Unlike Wile E. Coyote, who can fall off of a cliff and simply get back up and go back to the drawing board, a generating station has obligations to its customers and stockholders to provide reliable, cost-effective electricity. Failure to achieve **lowest cost** reliability is unacceptable.

In a plant where the work management process is functioning well, work is identified in a timely way and sent to the planner with all required information already on the work order. The planner prepares detailed job plans that include all elements that could possibly help the craftsperson perform the work better and more quickly. Job plans include estimated labor hours, estimated materials requirements, detailed job steps, equipment prints and any other helpful information.

Work is not scheduled until it is clear that it will be ready to be worked when the scheduled day arrives. On weekly and daily schedules, crews and craftspeople are given no more work than they can accomplish and no less. The most important work is placed on scheduled first, and that includes a large percentage of preventive and predictive maintenance.

Craftspeople are not given work until the job is ready to be done. The equipment has been cleared and prepared. The materials are available to do the job. Coordination between crews and contractors has happened. Craftspeople will not be pulled off the job because Operations has agreed to the work on the schedule through joint prioritization in the scheduling meeting.

Ultimately, more work gets done, of higher quality, in less time, with less stress on employees when obstacles that impede them are removed from the process. They are allowed to perform at the high level they have wanted to achieve all along.

The following sections provide in detail, the procedures and activities that are recommended in order to fully implement planning and scheduling.

4
DEVELOPING THE ORGANIZATION

Everyone would like to have better, lower cost maintenance; many try to achieve it but few succeed. Why do so many work management improvement efforts fail? These efforts may be as comprehensive as redesigning the entire work management process or focusing on a couple of critical work process elements, such as planning and scheduling. These efforts may not fail miserably. Perhaps they simply fail to live up to their promise. Still, there is a conspicuous aura of disappointment and intractability to maintenance excellence.

Value of Developing Your Organization

The value of good work management practices, example, improving your planning and scheduling, is unseen by many executives and managers. Its central role in the day to day life on the plant floor is unappreciated. Improving elements of your work management process is more than equipment repair, more than preventive maintenance. Work management is the most important business process in an industrial organization. If the work management process is well designed and disciplined, productivity is real and comprehensive, and lowest cost reliability is the inevitable result. Also many executives and managers see salvation in advanced maintenance programs like PDM or RCM. These programs are valuable tools, pillars of proactive technology and thinking. The problem with proactive maintenance is that it can't be effective if, day to day, you are mired in reactive work.

Often the one area that gets ignored when maintenance work management improvement efforts are ready to be implemented is the readiness of your organization/work culture to make these improvements. Another, perhaps more acceptable, term for work culture is work environment. The readiness of your organization implement change and make improvements is the bogeyman of most improvement efforts. We hide under our beds, fearing what, in the light of day, is merely a shadow of ourselves. Having your organization and work culture ready is powerful, it has a tremendous impact on productivity, but it is also dissectable and manageable.

Every organization/plant has a unique work culture. Those that succeed in improving work management acknowledge and embrace the existence of their work culture, and then they manage it. Addressing the work culture is a scary subject for many, it seems to lack the hard edge of objectivity that makes technical problems addressable and fun. People do things for two reasons, process reasons and personal reasons. Process reasons are about duty and responsibility, they represent getting the job done. Personal reasons are about comfort and motivation, they represent getting along and getting ahead. If an organization allows any misalignment between process and their unique work culture, people will always lean toward the personal side of the equation and that is a recipe for inconsistency.

Your work culture is as manageable as any other part of the business. In essence, addressing your work culture is management - you don't manage equipment, you manage people. Your work culture is managed the old fashioned way, by setting expectations and making sure people live up to them. We call it making and keeping commitments. The commitments are made in a well-defined work management process and they are lived up to in as system of accountability. Accountability is the "latch" that keeps process and work culture aligned.

There are three conditions that drive any organizational change, including changing your work culture. They are clarity, consensus and commitment:

Clarity: Universal understanding of where we are now, where we want to go and how we are going to get there

Consensus: General agreement (not unanimity) on the clarity items

Commitment: **Reality**; real dollars, real hours, high-quality people

Priority; forsaking other important tasks to make change happen

Perseverance; staying with the program, not caving in to resistance

When these conditions exist, an organization's potential is boundless. Every phase of your improvement approach should revolve around creating or maintaining these conditions. The assessment phase is an important beginning. People need to take a hard look at what they do, and do not, do well. But the implementation phase is where real change is achieved. To be real, new behaviors must be institutionalized, they must become the new status quo. Foundation building involves employees in defining and generating change. The result is a change process that is faster, smoother and longer lasting.

To begin, it is first necessary to examine the steps involved in making organizational change. We will then examine the challenges of organizational change as they relate to each of these steps:

1. **Assessment** of organizational beliefs and the practices they foster

2. **Address Work Culture Issues** by dismantling outmoded beliefs and creating a vision for the future

3. **Implementation** of the new vision and a system of accountability

4. **Reinforcement** of the beliefs and institutionalization of desirable practices

The Improvement Model is represented in the following diagram. It begins with the Assessment step and flows in a circular pattern to emphasize that the process never truly ends. Following Implementation, the Reinforcement step takes over in the spirit of continuous improvement, feeding back into Implementation. It touches on Assessment and Foundation Building to accommodate the need to go back and re-challenge the organization to be certain of its course.

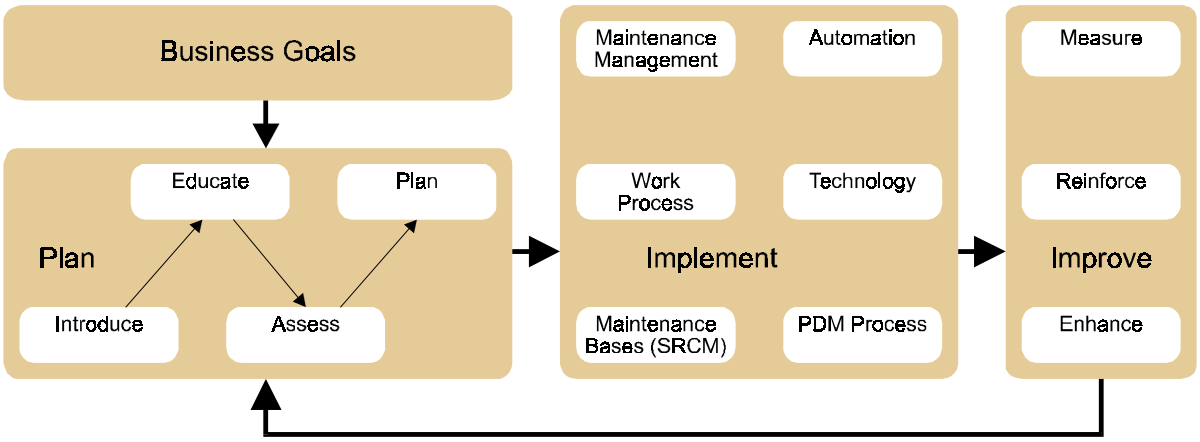


Figure 4-1
Improvement Model

When an organization is changing the way it does business, there are two types of issues it must address. Technical issues like equipment performance are addressed with technical solutions such as engineering design or modification. Most capital projects are technical solutions. Striving for best practices is not a technical problem and it cannot be solved with technical solutions like a new computer system or a predictive maintenance program. Achieving best practices is a human problem and it must be addressed with a management solution. When the problem is redefined as managerial, then the right tool for the job is a work management process whose design is robust and whose discipline is consistent.

Therefore, in an effort to reach best practice levels and sustainable value in your planning and scheduling efforts your entire organization/plant and the associated work culture must be ready to make the necessary changes.

5
BEST PRACTICE

The following sections provide in detail, the procedures and activities that are recommended in order to fully implement planning and scheduling.

Planning

Some jobs require a minimal level of planning while others that are more complex require very detailed plans and advance coordination. Elements of a well-planned job include labor estimates, materials and parts estimates, detailed job steps, contractor requirements, specialty tool requirements, coordination between internal crafts and with dispatch. The following procedures describe the requirements for work planning for all work order types.

Typically, the Maintenance Superintendent is accountable for the health of the work planning process and for ensuring that all defined work planning tasks are completed thoroughly and efficiently by the responsible personnel. This means that he/she must follow up frequently with planners on the status of the backlog and plan quality, communicate with maintenance supervisors and crews to ensure that work order plans are complete and useful, and reinforce to other members of the organization what planners require to do their jobs effectively (such as detailed work order problem descriptions). In general, the Maintenance Superintendent is responsible for setting clear expectations for all participants in the planning process.

Work Planning Procedure

Minimum Requirements for a Planned Job

The first step in planning is to define the level of planning required for a particular job. Some jobs will require only a minimal amount of planning, but it is important to define what those minimum requirements are. The following activities are basic requirements for any job to be considered truly "planned."

- Ensure the correct equipment identification number is on the work order (this will also ensure that the correct accounting code is on the work order),
- Prepare a labor estimate for all crafts involved in the job,
- Create a list of what parts and materials will be required for the job and estimate their cost,
- Determine if the parts and materials are available and order or purchase as necessary,
- Determine what clearances are required and prepare clearance request forms,

- Change the status of the work order in the CMMS to indicate that it is ready to be scheduled,
- Print a copy of the work order, the work order plan and the Planning Checklist and place with the clearance request form(s) in the job package.

More In-Depth Planning

Some work orders may require considerably more detailed planning. This can include more research, field job scoping, or troubleshooting the problem with the originating department.

Field Job Scoping

Many maintenance jobs would benefit from being scoped in the field. That is, the person doing the planning should actually go to the job site so that job steps, materials planning and labor estimates (including even the number of people that can fit into the work space) can be as precise as possible. Looking at the problem can also help clarify the job priority.

Even for recurring jobs conditions can change. There may be new developments that relate to safety. Equipment access may be hampered by scaffolding or by new equipment that has been installed. Equipment may need cleaning or lights may have burned out. Any needs that can be anticipated, from ladders to power washers to confined space permits speed up the work and make it more likely that the job will be done correctly and safely.

Other Elements that can be Included in the Job Package

The following elements can be researched and included in the job package as necessary.

- Detailed job steps (these may include readings that must be taken before or after work completion),
- Prints, drawings or OEM manual pages,
- Location of parts (i.e. parts kits or staged parts),
- Bills of Material (BOMs),
- Special conditions that have occurred in relation to the job (e.g. fabrication of parts, vendor contacts to date, calibration data, etc.),
- Equipment history,
- Predictive Maintenance (PDM) data,
- Material Safety Data Sheets (MSDS),
- Safety equipment,
- Identification of outside resources,
- Special tools or equipment,
- Identification of training opportunities,

- Other craft requirements and coordination,
- Sketch that may aid the work performer in completing the job,
- General comments,
- Other job packages for work that may be completed on the same equipment at the same time.

Responsibilities

As with any process, it is imperative that roles and responsibilities for each process participant be clearly defined and communicated. If specific responsibilities are not defined and documented, it is impossible to hold people accountable for their part in the process. The more detail that is provided, the more likely it is that process integrity will be maintained. Following are sample responsibility definitions for planners and maintenance supervisors.

Sample Planner Responsibilities

- Closely adhere to the planning process as described in the work process manual.
- Gather all necessary information per the planning process guidelines and develop the job package.
- Prepare the job package and place it in numerical order (according to work order number) in the appropriate scheduled week in the file cabinet. Each craft and crew will have file folders designated for scheduled weeks.
- Review the information supplied by the 1st Line Supervisor in order to identify problems and suggestions for improved job packages.
- Review run, repair or retire issues with the 1st Line Supervisor.
- Update standard job plans in the CMMS.
- Update preventive maintenance master files to adjust frequencies.
- Return originals of OEM manuals and prints.

Sample Maintenance Supervisor Responsibilities

- Retrieve the job packages from the file cabinet for jobs scheduled in week one and review them for accuracy and completeness.
- After performing the work, write comments on the work order plan to include the following type of information.
- Identify when man-hour estimates were too high or too low.
- Identify if the job steps were complete and accurate.
- Identify if the parts and materials were complete and accurate.
- Identify other job package elements that could be improved.
- Return the job package to the planner.

Scheduling Process - Multi-Week Management

The purpose of Multi Week scheduling is to ensure that the highest plant priority work is being completed on a weekly basis and that clarity, consensus and commitment regarding work to be done is achieved through joint prioritization. Work is selected based on what is important to the operation of the plant in order to maximize availability and minimize cost. Preventive and predictive maintenance are essential to accomplishing these goals. Effective long-range scheduling will aid in ensuring that these activities are accomplished consistently.

The Multi Week Scheduling Process is a system used to plan and execute all on-line and off-line maintenance. It is a well-integrated, interdepartmental plan that will promote employees to work safely without challenging operations or power generation, and, ultimately, reduces the cost per kilowatt-hour.

The process is designed to ensure that the work identified at the initial stage equals the work completed at the end of the cycle. It also provides clear direction for integrating emergency work and sponsored work into the process so that it doesn't adversely impact the schedule. The Plant would be able to track every job that enters the system from start to finish, whether it is a modification that is a project with a due date, or maintenance work that is scheduled in a Multi Week cycle.

While the Supervisor reporting to the Plant Manager is the primary owner of the P&S Processes, there is a need for support from all other groups on site to complete the jobs as scheduled in the P&S Process.

Schedules are prepared for each crew for the Multi Weeks following the current week, henceforth referred to as Week T4, T3, T2, T1, and T0 (see Figure 5-1). Note that various multi-week scenarios can exist depending on the unique situation at the plant. Which work will be scheduled first is a matter of plant policy and joint prioritization, however, it is recommended that preventive and predictive maintenance (PM and PDM) be the first items included in each of the Multi Weeks, followed by higher priority corrective work and capital projects or modifications. Each week the available labor is scheduled up to the following approximate amounts:

- * Week T4: 30%
- * Week T3: 50%
- * Week T2: 70%
- * Week T1: 70%
- * Week T0: 100% this is the week work is executed

Work is scheduled against available labor resources, but only as man-hours available vs. man-hours estimated for jobs for the entire week. Individuals can be matched up with jobs before the workweek or during the daily scheduling process depending on a craft person's special skills and on coordination with other groups. Specific start dates within the week are not identified unless they are required for coordination of resources or power production.

The intended outcome of Multi Week scheduling is published schedules for all Maintenance crews, Coal and Yard crew, Operations crews and Engineering personnel.

Then, each day during work week T0, weekly scheduled work plus emergency and sponsored work are combined in a daily schedule that reflects 100% of the available labor for each crew. It is at this time that matching jobs up with individual craftspeople is finalized.

As work week T0 comes to a close all work incomplete or not started will be "rolled over into subsequent work weeks." While emergency work must be done immediately, daily and weekly sponsored work, although sometimes necessary, is costly and frustrating and should be avoided when feasible.

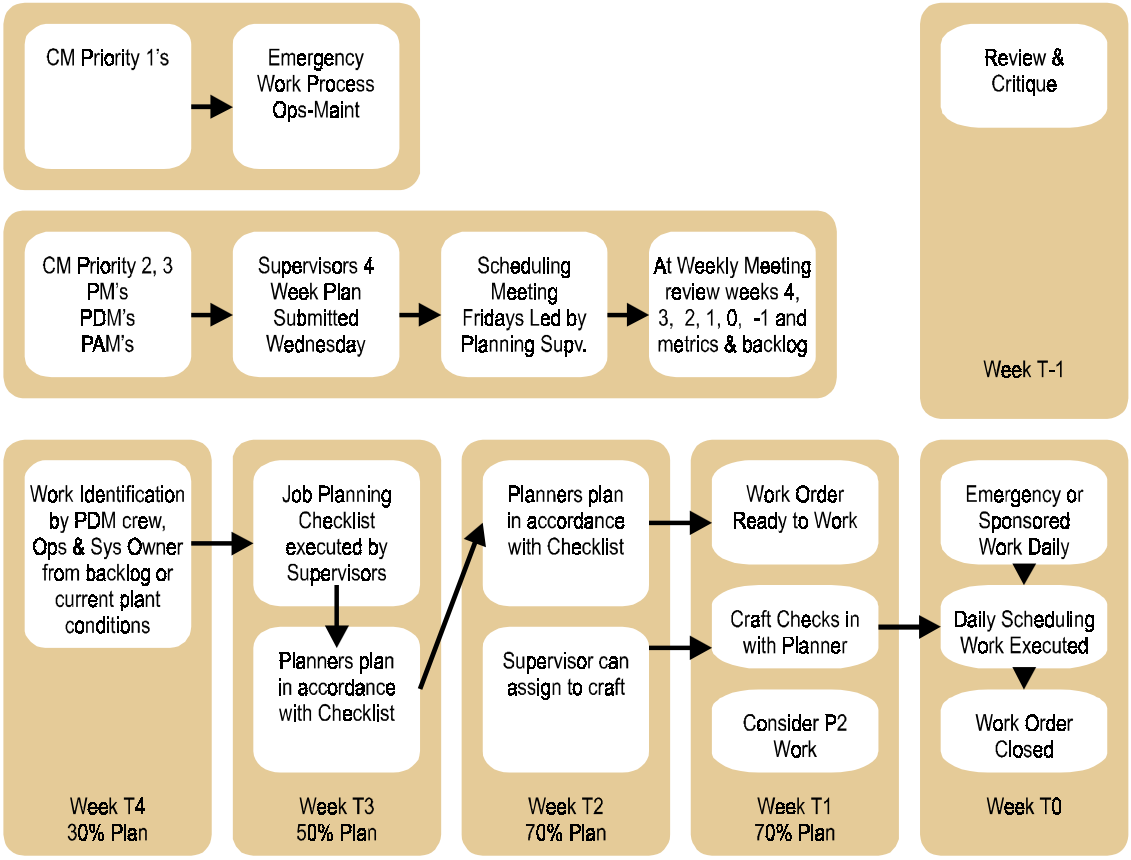


Figure 5-1
Example: Scheduling Work Process

Multi-Week Scheduling Process

The following section describes the significant steps in the workweek management processes. For all online work that will be contracted to vendors, or worked by site resources, a due date will drive the planning and scheduling and be incorporated by WO into the multi-week work cycle. Offline work scopes will be updated and maintained for unscheduled maintenance and forced outages while outage scopes for annual planned outages will be developed well in advance.

Work Week Process

The work week process will consist of a rolling Multi Week schedule, such as a four week schedule, developed by the plant schedulers with input from joint prioritization between System Owners, Planners, Maintenance, Operations and Engineering. These workweeks will be updated weekly at a Weekly Scheduling meeting. A standard Planning and Scheduling Form, such as Figure 5-2 should be used.

In order to drive this work week management process, a series of tools and transactional meetings should be used. These are:

- Joint Prioritization
- Weekly Scheduling Meeting
- Standard P&S Form

Joint Prioritization

Effective planning and scheduling cannot occur without the joint prioritization process. Joint prioritization is the continual evaluation and re-sequencing of work needs. This process begins following work approval and ends at work completion. Joint prioritization is performed by operations, maintenance and any other stakeholders, resulting in mutual agreement on the right work, at the right time and with the right resources.

Weekly Scheduling Meeting

The purpose of the meeting is to obtain commitment for all responsibilities to the workweek schedules. The meeting is designed to provide clarity about the jobs to be worked, consensus as to the most important work to be scheduled and establish commitment to accomplish the scheduled work. This will enhance teamwork, communication and coordination and assist in the scheduling of day-to-day maintenance and project activities. During this meeting each workweek work plan and resource allocation will be discussed. This is a decision-making meeting with input from all plant sources. The work plans are validated and schedules set. Periodically the group will direct their focus to a quarterly and end of year projection. During budget time the next year and five-year budgets will be reviewed and prioritized with input from the group.

Standard Planning and Scheduling Form

Figure 5-6 is an example of a standard Planning and Scheduling Form. Such a form must, among other things, provide for documenting the available labor resources for the workweek, documenting the scheduled work for the workweek, documenting the disruptive emergency and sponsored work completed during workweek T0, and calculating the P&S metrics. There will be one P&S Form used for each first line supervisor responsible for maintenance work execution.

Activity by Week

Week T4 - Work to be Performed 4 Weeks Away

Labor availability information is required each week, for the above mentioned crews, for the upcoming Multi Weeks. Gather the information required to complete the labor availability portion of the standard P&S Form. First Line Supervisors discuss availability with crew members.

During this week the PDM Group submits its priorities on work driven by condition. Additionally, the system owner will review system equipment indicators for impending problems, reviews and prioritizes the outstanding work on the system. The system owner identifies a recommended job list for the window 4 weeks away.

During this week, the Schedulers make sure a joint prioritization takes place for work to be placed on the T4 workweek. At the weekly scheduling meeting, joint prioritization can be agreed to in relation to all work assigned to the various workweeks.

Planners will begin planning on jobs identified for week T4 as required.

Week T3 - Work to be Performed 3 Weeks Away

Labor availability information is required each week, for the above mentioned crews, for the upcoming Multi Weeks. Gather the information required to complete the labor availability portion of the standard P&S Form. First Line Supervisors discuss availability with crew members.

Operations reviews and inputs on the prioritization of work.

Planners will continue planning on jobs identified during week 4 as required

Week T2 - Work to be Performed 2 Weeks Away

Labor availability information is required each week, for the above mentioned crews, for the upcoming Multi Weeks. Gather the information required to complete the labor availability portion of the standard P&S Form. First Line Supervisors discuss availability with crew members.

Schedulers ensure that all man-hour estimates are correct and that all planning holds removed from jobs in workweek by the end of business on Friday.

Materials management to ensure all parts are available for the jobs in workweek by the end of business on Friday. Staging of parts may be started at this point.

Supervisors review their available man-hours for the workweek and compare to the scope of the window and COMMITS to the schedule. Notify Supervisor of Planning and Scheduling of any discrepancies by the end of business on Friday.

The Supervisor Planning and Scheduling performs a final evaluation of the workweek. At this time, the Planner will remove from the window any work where parts will not be ready. The Supervisor Planning and Scheduling also assures the Operations Specialists and Supervisor - Operations' agree to the feasibility of the pending clearances required.

After this week, any work added to the work week must receive management approval in accordance with the Sponsored and Emergency work process.

Supervisors submit the final daily schedule to the Supervisor Planning and Scheduling on Friday.

During this time, the Supervisor - Operations begins preparation of the clearances required for the week. He solicits the assistance of the system owner for a technical review of clearances when specialized system knowledge is required.

Week T1 - Work to be Performed Next Week

Labor availability information is required each week, for the above mentioned crews, for the upcoming Multi Weeks. Gather the information required to complete the labor availability portion of the standard P&S Form. First Line Supervisors discuss availability with crew members.

On Monday of week 1, all work is incorporated into a master Work Week schedule.

After this time, additions and removals can only be made through the Supervisor of Planning and Scheduling.

On Friday, work that will roll over from T0 into T1 is identified and entered into the schedule.

Supervisors review their available man-hours for the workweek and compare to the scope of the workweek and COMMITS to accomplishing all work. Notify Supervisor of Planning and Scheduling of any discrepancies by the end of business on Friday

Supervisors can begin to assign the work to specific personnel, and obtain buy-in to the schedule.

The Supervisor walks down the jobs in the week as necessary to identify possible conflicts.

The Supervisor of Operations meets with the Supervisor of Planning and Scheduling to review Work prioritization and ranking and the clearance plan. Clearance preparation and final approval are completed.

The Rev 0 schedule reflecting >70% of net available resources, is issued to the plant 11 AM Friday.

Week T0 Work Execution Week

This is the execution week. All added work must go through the Sponsored/Emergency work process and obtain Supervisor level approval.

Operations will prioritize sponsored and emergency work.

Daily meetings are held to discuss new priorities of emergent work.

Week T-1 Last Week in Review

Work week critique. Review schedule compliance, what went well, what did not go well during the week and set appropriate compliance goals.

Unplanned Outage Process

The Supervisor of Planning and Scheduling will be responsible to keep an updated unplanned outage work list. This list will consist of work to be done offline with the estimated job duration, man-hours, and relative importance ranking. This list will be utilized for work planning in the event of an unplanned outage. The work selected will depend on the outage duration limits, critical path and resources at time of outage.

1. Special unplanned outage meetings can be called if time permits to discuss last minute work scope requirements.

2. If time does not allow special meeting then the Supervisor of Planning and Scheduling is responsible to select work from list within constraints of outage circumstances.

3. For appropriate work orders, planners should develop Work Packages.

Definitions

Emergency Work (Only Priority 1 Work)

Definition: Any equipment failure that requires immediate return to service. Work is to be performed during the current workweek. Emergency work must be Supervisor approved and presented at the daily status meeting.

Emergency work will be held to a minimum

Sponsored Work

Definition: Work that is to be added to the schedule between Week T0 and Week T1. Work that is required with more urgency than the multi-week scheduling allows but does not fit Priority

1 criteria. The operations sponsor makes the decision and takes responsibility to allow this work to bump other scheduled jobs.

Sponsored work will also be held to a minimum due to the schedule disruptions that result from it.

Work Backlog

In order for effective planning and scheduling to take place, the organization must have an organized and accurate backlog of maintenance work. If organizing the backlog is setting up the structure and codes to help an organization manage the workload, then maintaining the backlog refers to the constant activity of updating data within that structure to ensure that the information derived from it is accurate. This is key, for if everyone in the organization doesn't work towards this end, then the backlog as a decision making tool becomes suspect and will once again fall into disuse. Maintaining the backlog is not the responsibility of one person or group, it is everyone's responsibility. It should not be viewed as a task that is separate from each person's daily routine. The backlog is a tremendously powerful tool that will maintain itself if people wholeheartedly incorporate it into their daily job functions. To ensure that the backlog is properly maintained, every of the work management process should address the roles and responsibilities, by job position, for using and maintaining the backlog.

Think of the backlog as the fuel supply for the work management process. Just like fuel for an engine, backlog must be managed and cared for. Managing the backlog means using the backlog daily as a tool to make decisions, decisions about what to plan, what to schedule, how many craftspeople are needed, when to take equipment out of service, when to use contractors, when to schedule vacations, et cetera. Caring for the backlog means ensuring that every job is accurate, accuracy of job information, job plans and labor estimates, status coding and routing. Caring for the backlog also means promptly removing jobs when they're completed.

Responsibilities to the Workweek Schedules and Scheduling Meeting

Operations Superintendent

Preparation

- Reviews the schedule for operability concerns.
- Coordinates all clearances for sponsored and emergency work.
- Provides input to Supervisor Planning and Scheduling concerning maintenance tasks performed by the operations craft.
- Coordinates all clearances for load drops or forced outages are written and approved prior to the event.
- Provides operational start up and shut down sequence schedules and incorporates any testing required during the sequence.

- Ensure Operations Supervisors are aware of any post maintenance tests or performance tests that require rescheduling.
- Writes all clearances required for the respective work week in a timely manner to support having them approved by the end of week T1.
- Works with the Supervisor P&S during weeks 4,3, and 2 to finalize the details of the workweek schedule. A review of all work activities scheduled for each week is performed to screen work significant to Operations and to ensure proper controls are established.
- Review multi-week schedules with the Planner/Analyst prior to the meeting to ensure an understanding of the content and to anticipate conflicting priorities.

During Meeting

- Attend the meeting per the standard agenda.
- In cases when consensus cannot be reached among participants, assure the final decision with input of the Maintenance Superintendent.
- Accepts the finalized Week T1 schedule and remains responsible for all schedule problems or issues with clearance or testing for that workweek.

Post Meeting

- Ensures all clearances are approved by the end of week T1.
- Responsible for daily emergent work and communication with maintenance and Planning and Scheduling for schedule impacts.
- Informs the Supervisor Planning and Scheduling of any sponsored and emergency work that is planned in the week. (This includes a detailed schedule of the plan for the work).
- Provide support to the Planner/Analyst in obtaining cooperation from outside groups or services (operations related items).
- Supports schedule during execution week including Post Maintenance Testing and Performance Testing.
- Verifies all testing is performed as scheduled.
- Follow-up to ensure that action items are accomplished between meetings.

Maintenance Superintendent

Preparation

- Review issues impacting weekly Mechanical, I&C and Electrical schedules with 1st Line supervisors.
- Assure work requiring planning is prioritized and fully planned on a timely basis.
- Examine changing plant priorities and the planned backlog.

- Understand the status of work planned.
- Work with the Planner/Analyst to ensure work is divided appropriately between the mechanical maintenance schedules and that the division coincides with plant priorities.

During Meeting

- Assist in ensuring appropriate coordination between crafts.
- Identify and resolve resource issues (i.e., temporary manpower needs, specialized equipment or outside services).

Post Meeting

- Follow-up on and resolve resource issues identified during the meeting.

Supervisor of Planning and Scheduling

Preparation

- Loads initial schedule (work to be done that week) for the Work Weeks T0 to T4 by incorporating the results of Joint Prioritization and previous Weekly Scheduling Meetings.
- Owns the schedule and makes all changes to the week T4 to week T0 scope.
- Makes necessary logic ties.
- Incorporates all details from First Line Supervisor (including resource allocation).
- Coordinates jobs with Operations and Maintenance Supervisor.
- Develops and maintains planned and unplanned outage work scopes and schedule.
- Chairs regular meetings to discuss and develop the work scope for unplanned outages.
- Serves as Work Scope Coordinator when a forced outage occurs.
- Coordinates the running unit work schedules with the outage unit work schedules.
- Meets with Supervisor - Operations two weeks prior to the workweek to obtain buy-in from the implementing operations crew.
- Coordinates the development of work packages on planned work.

During Meeting

- Chairs the Weekly Scheduling Meeting to integrate work requirements of each unit together with the resources of the plant.
- Facilitates go/no go decisions on maintenance tasks, and facilitates decisions with respect to repair or patch on specific tasks when required.

Post Meeting

- Develops and distributes the schedule so that it can be successfully executed.
- Tracks budget vs. actual.
- Provides Rev 0 schedule to shift management by the afternoon on the Friday preceding the actual workweek.
- Publish schedule during execution week.
- Can chair the Daily Scheduling meeting for emergency work and schedule problems.
- Performs critique of feedback and schedule compliance of the workweek.
- Develops and publishes performance indicators and schedule compliance for each workweek.
- Responsible to manage the work backlog of the plant.
- Follow-up on and resolve resource issues identified during the meeting.

Planner/Analysts

Preparation

- Planner must work with Supervisor Planning and Scheduling to provide input on job plan readiness for scheduling within workweek planning window.
- Job plans will include a description of the work that needs to be done, what sequence, drawings, repair specifications, skills, tools, parts, procedures, estimated man-hours, duration (start to finish), and what safety issues are required for successful completion of the job.
- All job plans must be complete by the end of week T1.
- Planner develops job plans for planned and unplanned outage scopes. Job plans must be prepared before placing on unplanned outage work list.
- Retrieve available labor data from all groups. If labor availability information was provided in a manual fashion from any supervisor, document on appropriate P&S Forms.
- Identify all work orders entering the Multi Week schedules requiring significant planning and assign planning accountability.
- Examine short-term needs by maintaining contact with the Power Broker to identify the best time to perform load-limiting maintenance.
- Examine changing plant priorities and the planned backlog.
- Prepare tentative multi-week schedules on their P&S Forms for each first line supervisor responsible for maintenance work.
- Communicate tentative multi-week schedules to meeting participants via Local Area Network no later than one full day before the weekly Scheduling meeting.
- Capture all changes to weekly schedules based on participant input, discussion and consensus.

During Meeting

- Provide the status of, or other information related to, critical scheduled jobs being worked.

Post Meeting

- Takes output of Weekly Scheduling Meeting and Daily Scheduling Meeting to develop job plans as required.
- Using the advanced weekly schedules, the planner will prepare job plans on those WO's requiring more significant preparation time.
- Finalize multi-week schedules.
- Coordinate and submit clearance requests for large, multi-craft jobs.
- Communicate to System Operations the scheduled work that will impact load capabilities.

1st Line Supervisors of groups performing maintenance

Preparation

- Determine weekly labor availability and provide this information to the Planner/Analyst.
- For jobs that will be performed over multiple weeks, attribute the amount of time to be worked during the given workweek.
- Update the T0 work week schedule with all emergency and sponsored activities worked on.
- Record on the T0 schedule the actual hours worked on the jobs and job status at the end of the week.
- Determine the status of jobs on the current T0 weekly schedule.
- Identify any potential roll-over of scheduled work.
- Examine changing plant priorities and the planned backlog.
- Identify and notify the Planner/Analyst of PM, project and other critical or aging backlog jobs requiring scheduling.

During Meeting

- Provide the status of, or other information related to, critical scheduled jobs being worked.
- Highlight coordination needs on any jobs involving other crafts.

Post Meeting

- Print and post the multi-week schedules in each designated crew area.
- Gather planned job packages and develop daily schedules.

Plant Supervising Engineer

Preparation

- Determine weekly Engineering labor availability.
- Prepare tentative multi-week schedules for the Engineering department.
- Determine the status of jobs on the current Engineering weekly schedule.
- Examine changing plant priorities and the planned backlog.
- Identify and notify the Planner/Analyst of PM, project and other critical or aging backlog jobs requiring scheduling of any crafts.

During Meeting

- Provide the status of, or other information related to, critical scheduled jobs being worked.
- Capture any changes to Engineering schedules.
- Highlight coordination needs on any jobs involving other crafts.
- Provide input on project work requiring other craft resources (in preparation for outages or to support engineering needs).

Post Meeting

- Distribute the multi-week schedules to all Engineering personnel.
- Communicate and coordinate the finalized schedules with outside engineering groups.

Inventory Warehouse Supervisor

Preparation

- Work with the Planner/Analysts to ensure parts availability prior to scheduling.
- Review tentative multi-week schedules prior to the meeting to understand their content.
- Be aware of dates when parts staging will be required based on the discussion of schedules.

Post Meeting

- * Initiate parts staging based on the content of schedules finalized in the meeting.

All Participants

- Prepare any hard copies of the tentative weekly schedules required by you prior to the weekly scheduling meeting.
- Pursue and resolve assigned items on the action item list.

- Provide feedback on individual action items to Planning and Scheduling, as they are resolved during the week and during the meeting.

Standing Agenda for Weekly Scheduling Meeting

- Attendance
- Review progress on previous action items
- Review Metrics
- Discuss power needs for the next three weeks
- Review current T0 week's work
  - Important jobs completed
  - Work that will not be completed
  - Carry-over
  - Re-schedule
  - Overtime
  - Issues and concerns that impacted schedule compliance and work accomplishment
- Review Week T1 schedules
  - Major/Non-routine jobs
  - Coordination requirements
  - Manpower
  - Other crafts
  - Equipment
  - Outside resources
  - Potential problems
  - Achieve consensus and commitment on Week T1 work
- Review Week T2
  - All Work scheduled will be "Ready to Work"
  - Coordination requirements
  - Manpower
  - Other crafts
  - Equipment
  - Outside resources
  - Potential problems
  - Achieve consensus and commitment on Week T2 schedule

- Review Week T4
  - Identify all work entering schedule requiring planning and assign accountability.
- Review and confirm new action items

Standard Planning and Scheduling Form

Purpose

The schedule form is a tool designed to:

- Aid in ensuring documentation of joint prioritization of scheduled maintenance work. This is achieved through:
- Documenting priority jobs for scheduling based on input from Operations, Maintenance, other crafts and the Planner/Analyst as tentative weekly schedules are being developed,
- Documenting total weekly net available man-hours by craft or crew,
- Documenting total weekly scheduled man-hours by craft or crew,
- Documenting percent net available man-hours scheduled by craft or crew for the appropriate week,
- Reporting the above information for review and discussion of schedule content prior to and during weekly scheduling meetings,
- Achieving clarity, consensus and commitment, during weekly scheduling meetings, on the actual jobs that will be contained on finalized weekly schedules.
- Communicate finalized, scheduled maintenance jobs by crew, for upcoming weeks.
- Aid 1st Line supervisors and crews in discussing and understanding the highest priority scheduled maintenance work for the plant for upcoming weeks.
- Provide a tool to track emergency and sponsored work and their accountabilities.
- Provide a tool to assist in communication, cooperation and coordination required between crews.
- Aid in development of daily schedules.
- Provide for the Planning and Scheduling Metrics required for work management.

Responsibilities

- Responsibilities for developing the weekly schedules are defined within the Multi-week Scheduling Process. These responsibilities related to input to, development and review of tentative schedules by appropriate individuals in preparation for and during weekly scheduling meetings.
- The Planner/Analyst will develop and provide tentative and finalized weekly schedules. This procedure defines the appropriate entries on the schedule document.

Frequency

- Finalized weekly schedules for the upcoming Multi Weeks for all first line supervisors of maintenance activities will be prepared and distributed no less than once each week.

Daily Scheduling

The purpose of Daily Scheduling is to ensure that the highest plant priority work is being completed on daily basis, that clarity, consensus and commitment regarding work to be done is achieved through joint prioritization, and that clear expectations are communicated to crews for daily work assignments.

Daily Scheduling Meeting

Purpose

- Ensure regular communication, cooperation and coordination between Operations, Maintenance and other groups.
- Review recently completed work to ensure the customer is aware of critical jobs that have been performed.
- Review issues or concerns that impacted work accomplishment.
- Provide recognition for good communication, cooperation and coordination.
- Review current jobs to ensure understanding of status.
- Review tentative schedules for the next working day, including potential carry-over work.
- Establish a contract between the Operations and Maintenance departments for tomorrow's schedule.
- Discuss preparation requirements (clearances and equipment preparation) required of Operations.

Responsibilities

Preparation Prior to the Meeting

- 1st Line Supervisors review yesterday's important jobs completed.
- All Participants are prepared to discuss issues which impacted yesterday's schedules.
- 1st Line Supervisors review today's updated daily work schedules to assess current work progress and identify potential carry-over work.
- Shift Supervisors and 1st Line Supervisors review the work order backlog to identify urgent work that may require scheduling.
- 1st Line Supervisors develop tentative daily work schedules for the next working day.

- 1st Line Supervisors collect prepared clearances from planned work packages.
- 1st Line Supervisors develop tentative clearance requests for urgent jobs that may not have clearances already prepared.
- 1st Line Supervisors make copies of tentative daily schedules.

During the Meeting

- Operations follow the standard daily meeting agenda.
- All Participants provide necessary information per agenda item.
- 1st Line Supervisors capture changes to daily schedules.
- 1st Line Supervisors finalize clearance requests and give to Duty Shift Supervisor.

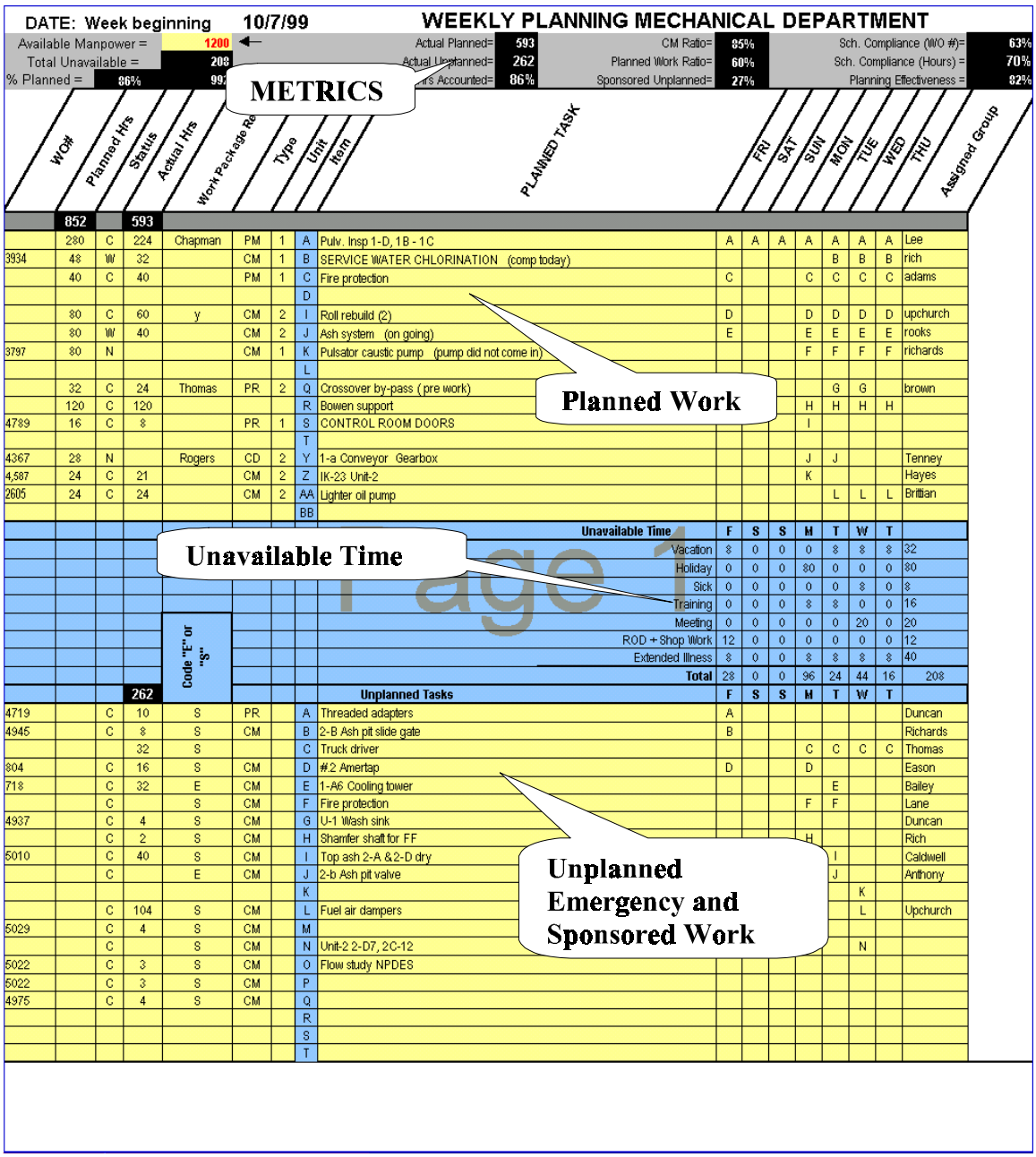
After the Meeting

- 1st Line Supervisors complete preparation of the daily work schedules for the following working day.
- 1st Line Supervisors place a hard copy of the finalized daily schedule in the box in the Shift Supervisor's office before leaving the plant.
- Shift Supervisor posts all finalized daily schedules in the Shift Supervisor's office.

Standing Agenda

- Review Yesterday's Work
  - Important jobs completed
  - Issues and concerns that impacted schedule compliance and work accomplishment
  - Positive recognition for good communication, cooperation and coordination
- Review Today's Work
  - Issues and concerns that have/are impacting work accomplishment
  - Potential carry-over work for tomorrow's schedule
  - Positive recognition for good performance
- Prepare for Tomorrow's Scheduled Work
  - Schedule carry-over work
  - Review plant priorities from the three-week schedules and the planned work order backlog
  - Discuss and agree upon tomorrow's scheduled work
  - Identify and discuss timing and coordination of jobs for start of shift, requiring clearances and requiring multi-craft involvement

Weekly Planning and Scheduling Form



	280	C	224	Chapman	PM	1	A	Pulv. Insp 1-D, 1B - 1C	A	A	A	A	A	A	A	Lee
3934	48	W	32		CM	1	B	SERVICE WATER CHLORINATION (comp today)					B	B	B	rich
	40	C	40		PM	1	C	Fire protection	C			C	C	C	C	adams
							D									
	80	C	60	y	CM	2	I	Roll rebuild (2)	D			D	D	D	D	upchurch
	80	W	40		CM	2	J	Ash system (on going)	E			E	E	E	E	rooks
3797	80	N			CM	1	K	Pulsator caustic pump (pump did not come in)				F	F	F	F	richards
							L									
	32	C	24	Thomas	PR	2	Q	Crossover by-pass (pre work)					G	G		brown
	120	C	120				R	Bowen support				H	H	H	H	
4789	16	C	8		PR	1	S	CONTROL ROOM DOORS				I				
							T									
4367	28	N		Rogers	CD	2	Y	1-a Conveyor Gearbox				J	J			Tenney
4,587	24	C	21		CM	2	Z	IK-23 Unit-2				K				Hayes
2605	24	C	24		CM	2	AA	Lighter oil pump					L	L	L	Brittian
							BB									
								Unavailable Time	**F**	**S**	**S**	**M**	**T**	**W**	**T**	
								Vacation	8	0	0	0	8	8	8	32
								Holiday	0	0	0	80	0	0	0	80
								Sick	0	0	0	0	0	8	0	8
								Training	0	0	0	8	8	0	0	16
								Meeting	0	0	0	0	0	20	0	20
								ROD + Shop Work	12	0	0	0	0	0	0	12
								Extended Illness	8	0	0	8	8	8	8	40
								Total	28	0	0	96	24	44	16	208
			262					**Unplanned Tasks**	**F**	**S**	**S**	**M**	**T**	**W**	**T**	
4719		C	10	S	PR		A	Threaded adapters	A							Duncan
4945		C	8	S	CM		B	2-B Ash pit slide gate	B							Richards
			32	S			C	Truck driver				C	C	C	C	Thomas
804		C	16	S	CM		D	#2 Amertap	D			D				Eason
718		C	32	E	CM		E	1-A6 Cooling tower					E			Bailey
		C		S	CM		F	Fire protection				F	F			Lane
4937		C	4	S	CM		G	U-1 Wash sink								Duncan
		C	2	S	CM		H	Shamfer shaft for FF				H				Rich
5010		C	40	S	CM		I	Top ash 2-A &2-D dry					I			Caldwell
		C		E	CM		J	2-b Ash pit valve					J			Anthony
							K							K		
		C	104	S	CM		L	Fuel air dampers						L		Upchurch
5029		C	4	S	CM		M									
		C		S	CM		N	Unit-2 2-D7, 2C-12						N		
5022		C	3	S	CM		O	Flow study NPDES								
5022		C	3	S	CM		P									
4975		C	4	S	CM		Q									
							R									
							S									
							T									

Figure 5-2
First Figure Caption

6
METRICS

Like other complex functions, planning and scheduling effectiveness require a package of measures to represent it accurately; no single measure will do, and single measures should not be taken out of the context of the package lest the information cause misunderstandings and possibly be used inappropriately. However, it is possible to select too many indicators, which dilutes the importance of a few key measures and fragments the attention of the management staff and planners responsible for the process.

For planning and scheduling effectiveness indicators, as with all indicator packages, it is not enough simply for them to exist. They must be used. The indicators should be reported frequently with little lag time between the period or event and its report, in order to reinforce good results and give early warning of bad results. Reports should be widely distributed, posted and discussed. In addition, indicators must be effective in supporting strategic decision-making and maintaining the health of the work management process.

The data of which reports are comprised must be collected in as easy and automatic a way as possible, so that data collection won't be sacrificed to day-to-day urgency and short-term priority. Data should have the following characteristics:

- Data collection: easy, automatic, timely
- Data integrity: resists manipulation, objective
- Reporting: fast, frequent, organized for comprehension, graphic
- Communication: distributed widely, posted, discussed formally
- Effectiveness: improving trends

The following metrics are leading indicators, they describe the health of the planning and scheduling process. They are sensitive indicators that can be used to improve processes before the results show-up in lagging metrics. Lagging metrics are the typical accounting bottom-line results of the process. Examples of lagging metrics are: availability, forced outage rate, capacity factor, total generation, heat rate, emissions, budget, total manpower, overtime, contractor non-outage hours, and hours on blanket WO's.

Most Important Metrics

The most important planning and scheduling metrics should be used at all plants irrespective of operating mode or effectiveness of the planning and scheduling process. These indicators are typically reported monthly. Once a month management should review these metrics. The actual

numbers don't matter as much as the trends from month to month, and the questioning and actions that occur in the meeting. Other metrics are suggested later, these could be used to address temporary problems or special conditions at a particular plant.

Table 6-1
Metric Values for Different Organizations

	Tasmanian Devil	Mr. McGoo	Wylie Coyote	Best Practice
PM Compliance	15%	40%	70%	100%
CM Ratio	90%	75%	50%	20%
Sponsored Work	70%	50%	30%	12%
Emergency Work	20%	10%	5%	1%
Resource Utilization (productive work)	14%	25%	40%	60%
Aged Backlog Histogram (on-line) (off-line)	growing growing	2 years old	1 year old	6 months old 1 outage
On-line Backlog (on-line)	14 weeks	8 weeks	4 weeks	2 weeks
Labor Planning Effectiveness	no planning	20%	40%	90%
Material Planning Effectiveness	no planning	15%	35%	80%
Backlog Planning Factor	not measured	0.3-1.7	0.6-1.4	0.9-1.1
Schedule Compliance (daily) (weekly)	no scheduling no scheduling	30% no scheduling	50% 50%	90% 90%
Percent on Scheduled Jobs	no scheduling	40%	60%	95%
Schedule Compliance Codes (Monthly and Rolling 12 Month)				

PM is all preventive work, whether is it time based, use based, or PDM data collection.

CM is all corrective work, whether it is unexpected, expected (run-to-failure), or to avoid imminent failure based on equipment condition (discovered by PM, PDM or PAM).

Table 6-2
Metric Definitions

	Definition
PM Compliance (%)	(# PM's completed)/(# PM's planned to be completed)
CM Ratio (%)	(total act. hrs. on CM WO's)/(total act. hrs.)
Sponsored Work (%)	(total act. hrs. on sponsored)/(total act. hrs.)
Emergency Work (%)	(total act. hrs. on P1-2 WO's)/(total act. hrs.)
Resource Utilization (%)	(total act. hrs. on all WO's)/(# workers * 40 + overtime)
Aged Backlog Histogram (%)	percentage of # P3 WO's at various ages
Running Backlog (weeks)	(total est. hrs. on P3 WO's)/(# workers * 40)
Labor Planning Effectiveness (%)	completed: [1-ABS(est. hrs.-act. hrs.)]/(est. hrs.)
Material Planning Effectiveness (%)	completed: [1-ABS(est. matl.-act. matl.)]/(est. matl.)
Backlog Planning Factor	total estimated hours/total actual hours
Schedule Compliance (%) (daily and weekly)	daily: (total daily sched. hrs.)/(total daily completed hrs.) weekly: (total weekly sched. hrs.)/(tot. weekly compl. hrs.)
Percent on Scheduled Jobs (%)	(total act. hrs. on scheduled WO's)/(total act. hrs.) hours on productive WO's; not training, sick time, etc.
Schedule Compliance Codes (%) (Current Month)	(total act. hrs. this month on each compliance code) (total # WO's this month on each compliance code)
Schedule Compliance Codes (%) (12-Month Total)	(total act. hrs. this year on each compliance code) (total # WO's this year on each compliance code)

In order to improve schedule compliance, it is necessary to discover the obstacles that impede adherence to schedules. It is not enough simply to measure schedule compliance and then expect employees to improve it without any information as to why schedules are being interrupted. The organization must provide a method for identifying the causes of schedule break-ins. Schedule compliance codes are a simple, but effective diagnostic tool for determining the what those causes are and their frequency of occurrence (and hence their cost to the organization). For each daily work assignment whose hours deviated plus or minus from the hours scheduled, the supervisor (with input from his/her crew) assigns a schedule compliance code to explain what caused the deviation. These codes are then totaled per month by hours and frequency of use.

Once the codes have been reported, the improvement team can review the data and look for ways to eliminate obstacles. Understandably, some schedule breakers are unavoidable. True emergency jobs cannot be postponed for the sake of schedule compliance. Short-term power demands may require equipment to remain in service. However, many schedule breakers are avoidable if thought and coordination are put into daily schedule preparation. Equipment

clearances can be prepared in advance, parts can be ordered and on hand. Even inclement weather can be forecast to a certain extent. Use of schedule compliance codes as a supplement to the basic schedule measures will provide employees with a method for diagnosing the problems so they can get to the work of eliminating or avoiding them.

Following is a sample set of schedule compliance codes. Frequently, plants that are implementing this tool will develop a far too lengthy list of codes that becomes confusing and cumbersome. A system of approximately twenty codes will provide adequate detail for analysis without causing supervisors and planners to become bogged down in which codes to assign to each job.

Table 6-3
Typical Compliance Codes

Manpower	**MUA - Unscheduled Administrative Duties**	**Crew member was unavailable for scheduled work because of other administrative. duties (Training, meetings, tours).**
	MAV - Manpower Availability	Crew member was off-site and not performing work related duties (Unscheduled absence, injury, rest period).
	MEB - Emergency Break-In	**Emergency unscheduled job that broke into schedule (Priority 1).**
	MNE - Non-Emergency Break-In	Non-Emergency unscheduled job that broke into schedule.
Planning	PLE - Job Took Less Time than Estimated	No particular problems with the job, just tool less time than the labor estimate.
	PME - Job Took More Time than Estimated	**No particular problems with the job, just tool more time than the labor estimate.**
	PAW - Additional Work Found	Job took more time because additional work was found after job began.
	POS - Impact from Other Scheduled Job	**Another scheduled assignment kept this one from being worked as scheduled.**
	PSE - Assignment Incorrectly Scheduled	Any errors, miscommunication regarding scheduling, i.e. job was unexpectedly completed the previous day.
	PIP - Incomplete Job Package	**Plan was inaccurate or did not have all of the elements required to do the job (prints, job steps, materials, incomplete scoping).**
Tools/Parts/ Materials	TCN - Computer/Network Issues	Computer or network malfunction delayed assignment.
	TIP - Incorrect Parts (Non-Stock)	**Problem with non-stock parts (not delivered, wrong parts, parts damaged).**

Table 6-3
Typical Compliance Codes (Continued)

	TII - Inventory Inaccuracy - (Stock)	Stock parts were unavailable for assignment.
	TBK - Tools Broken/Unavailable	**Includes vehicles.**
Equipment	QRS - Equipment Required for Service	Equipment custody could not be given or was delayed because it was required for operation.
	QNC - Equipment not Cleared	**Equipment was not cleared at time of assignment start.**
	QNP - Equipment not Prepared/Cleaned	Equipment was not cleaned and ready for work.
Environmental	**EIC - Weather Impact**	**Inclement weather, heat.**
	EHZ - Unforeseen Environmental Hazard	Acid leak, spill, dust, low 02.
Coordination	**COI - Coordination w/Internal Craft**	**Problem caused by miscommunication or coordination problem with an internal crew.**
	COD - Coordination w/Other Department	Problem caused by miscommunication or coordination with an internal department (Gas, Water, Human Resources).
	COO - Coordination w/Outside Organization	**Problem caused by miscommunication or coordination with an external group (Contractors, Consultants).**

Planning

A full indicator package can be created that will take into consideration the issues that exist at each site. For example, if Bills of Material (comprehensive spare parts and materials lists) have not yet been created for each piece of plant equipment, it may make sense to include BOM measures in the indicator package until the project of creating them has been completed. On the other hand, if the plant has a full complement of BOMs that only require routine updating, better indicators may be selected that are more apropos to what current planning goals are. Following is a list of possible measures separated by category.

Planner Productivity

- Unplanned backlog input rate and trend
- Number of work orders planned per day
- Percent of equipment for which Bills of Material (BOMs) are constructed

- Number of BOMs constructed per year
- Number of standard job plans
- Percent of work orders using standard job plans
- Ratio of planners to maintenance crafts
- Ratio of planners to maintenance supervisors

Plan Quality

- Percent of work orders completed without estimated labor hours
- Percent of all work orders completed that specify parts and materials
- Number and percent of work orders planned that have parts and materials reserved in the warehouse for the job
- Plan quality index (based on QA/QC audit of completed plans by team of crafts, supervisors and planners)
- Number and percent of work orders planned that have parts and materials delivered to the job site

Customer Satisfaction

- Customer satisfaction index (based on objective measures and attitude survey)

Results

- Number and cost of expediting parts and materials shipments
- Percent emergency work
- Equipment reliability and availability

Other

- Backlog size by craft, crew and work type
- Percent of work time allocated for field scoping
- Percent of standard job plans reviewed annually
- Percent of preventive maintenance tasks reviewed annually

Scheduling

The basic measure for measuring scheduling effectiveness is schedule compliance. While this may seem obvious, schedule compliance is often only measured with one indicator or it is done in ways that allow for easy data manipulation. It is recommended that daily schedule compliance

be measured in both hours and number of jobs completed. In addition, tracking the ratio of unscheduled to scheduled work completed is important. Finally, causes for schedule non-compliance should be documented using a system of schedule compliance codes. Long-range scheduling should be measured in percentage of scheduled jobs completed to ensure that the work that was agreed upon in the weekly scheduling meeting is being completed. It is recommended that the entire package be reported monthly, with the exception of daily schedule compliance in hours, which may be tracked weekly in order to report progress frequently to scheduling participants and to catch problems early. Following is a list of measures and formulas used to calculate them.

Daily Scheduling

- Scheduled Hours Completed: Actual hours worked on scheduled assignments, not to exceed the labor estimate for that day for each assignment
- Unscheduled Hours Completed: Actual hours worked on unscheduled assignments plus hours worked on scheduled jobs that exceed the labor estimate for each day
- Scheduled Assignments Completed: Number of scheduled assignments completed
- Unscheduled Assignments Completed: Number of unscheduled assignments worked, but not necessarily completed that day
- Schedule Compliance: Percentage of scheduled assignments completed
- Percent on Scheduled Jobs (Assignments): Percent of all assignments worked that were scheduled
- Percent on Unscheduled Jobs (Assignments): Percent all assignments worked that were unscheduled

Long-Range Scheduling

- Scheduled Assignments Completed: Number of scheduled assignments completed
- Schedule Compliance: Percentage of scheduled assignments completed

Note: As many jobs last more than one day, the term “assignments” refers specifically to the task that the supervisor has scheduled to completed for that day. The entire job need not be completed each day. Schedule compliance is measuring whether the crew was able to complete the specific tasks, or goals assigned for the day.

Other Measures that Support Planning and Scheduling

There are a number of supporting processes and tools that are critical to the success of planning and scheduling. These include, but are not limited to,

- complete and accurate work identification to enable more accurate planning and less time following up with originators to find missing information,

- thorough capital project and modification documentation (such as setting up equipment records, PMs and filing updated documents for new equipment) to ensure all important equipment is available for planning, and
- detailed work order histories for planners to use in assessing current equipment problems.

It is important to measure the quality of these supporting processes to ensure that planning and scheduling can be as effective as possible. Some possible measures are:

- Number of work orders missing important information
- Time between project installation and final project documentation
- Size of the drafting backlog
- Number and percent of completed work orders without failure codes and/or textual history
- Percent and cost of specialty tools not returned
- Number New WO's by type (critical)
- Number New WO's by type (non-critical)
- Number New WO's by priority (P1 & P2)
- CBM Avoided Costs
- Run-To-Failure costs per system

A typical priority system is:

Emergent work can be true emergencies (eg. generation reduction) or sponsored work.

Priority three work is backlog work, whether planned, scheduled or not completed. In general, scheduled work is not bumped from the schedule for higher priority work unless it is a true emergency.

Regardless of the measures selected, these processes must also be monitored. Effectiveness will suffer in spite of the best possible planning and scheduling processes in place unless the basic tools and information are available to planners. It is important to communicate to all plant employees that good planning and scheduling are everyone's responsibility.

7
HOW TO GET THERE

To begin, we will examine the steps involved in making organizational change. Then we will examine the challenges of organizational change as they relate to each of these steps:

1. Introduce and Educate the organization to industry best practice
2. Obtain Sponsorship from top management
3. Assessment of organizational beliefs and the practices they foster
4. Organization Alignment by dismantling outmoded beliefs and creating a vision for the future
5. Implementation Plan the identification of what will change
6. Implementation executing the new vision and a system of accountability
7. Reinforcement and Continuous Improvement of the beliefs and institutionalization of desirable practices

Steps 1 and 2. Management Sponsorship

The first two steps should result in obtaining management sponsorship to make the change. Failure to receive this sponsorship is sufficient not to proceed with change. The concept of planning and scheduling sounds simple, and the concept is simple. Getting it implemented is the challenge. Implementation is always the challenge in any new process because it is the work culture of the organization that requires the most effort to change, not the mechanics of doing work. Remember that planning and scheduling is where productivity is created in the work management process. Teamwork and the discipline to follow the work management process are critical ingredients to successful planning and scheduling, and ultimately to lowest-cost reliability.

Planning and scheduling requires organizational commitment. The steps, in the overall work management process, are only as good as the execution. If an organization is to achieve lowest-cost reliability, then it must be able to manage the process in a manner that ensures its effectiveness. This may be a significant cultural change for organizations that are accustomed to "fire fighting" as their approach to managing maintenance work. Given the depth of the change required and the potential strength of the internal opposition, it is imperative that management be a consistent and visible supporter of the change or the implementation will, in all likelihood, fail.

The Improvement Model is represented in the following diagram. After the organization has been introduced to the change and buy in is received and management sponsorship has been received, the improvement process begins with the Assessment step and flows in a circular pattern to emphasize that the process never truly ends. Following Implementation, the Reinforcement step takes over in the spirit of continuous improvement, feeding back into Implementation. It touches on Assessment, Organization Alignment to the change, building the change plan, and Implementation.

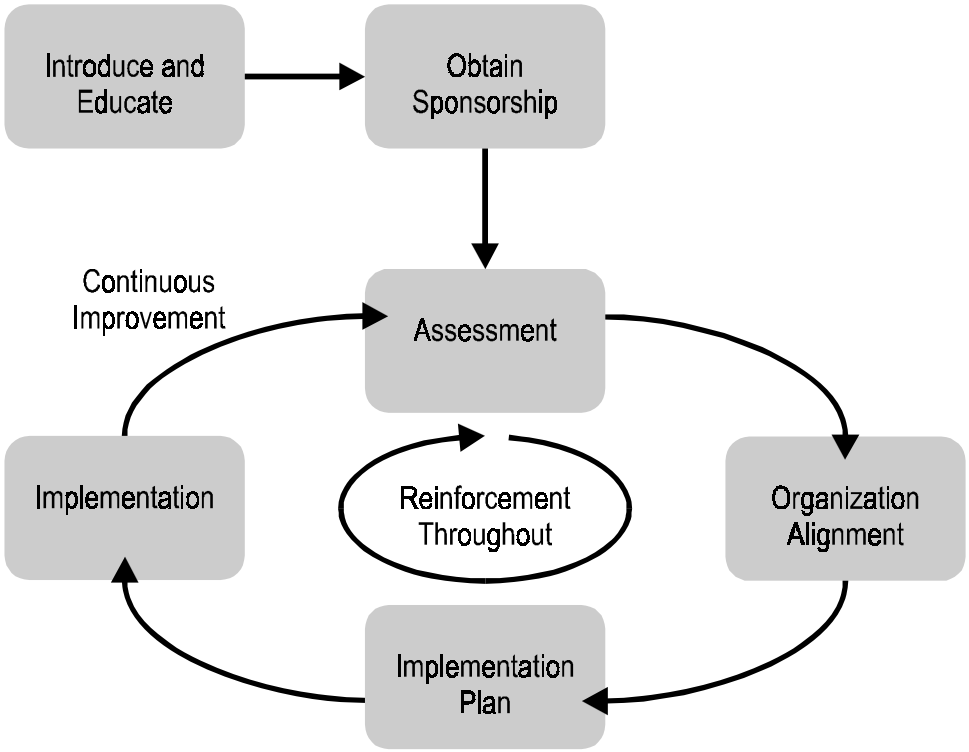


Figure 7-1
Managing the Change

Step 3. Assessment

Chances are that there is not a single issue, problem or condition which someone in the organization didn't already know about. This begs the question, then, of why hasn't this already been addressed? Because to change, an organization must know itself, its strengths and limitations, intimately. This means that change must start with a complete and fearless self-examination. Why fearless? A wise person once said that self-examination required a person to bear the extreme displeasure of being displeasing to oneself. Effective change requires an organization as a whole, and especially its leadership, to accept the responsibility for the current state of things and to bear any displeasure that might result from an honest appraisal. Honest assessment results in clarity about the organization's issues; it starts building consensus for the need to change and establishes the level of commitment that will be necessary.

The challenges of Assessment are:

- Willingness to look at oneself
- Establishing a state of psychological.
- Acknowledging what is not working
- Seeing and accepting what is

Assessment Includes

- **Discovery -** The first step is to learn about your organization. Use a number of methods to collect this information to ensure that the findings are accurate. Conduct interviews with plant employees of all levels. Spend time with them in the field educating yourselves about what is really going on in the plant. A printed survey can be a good way to collect a lot of information quickly, but it can't replace face to face communication.
- **Define Current Processes -** From individual and group interviews, detailed process flows can be developed that map out what truly happens on a day to day basis in the plant. Many organizations have flow charts of the "ideal" process. Developing flow charts of the real picture will allow you to identify where the organization has strayed from the preferred process.
- **Validate Findings -** While anecdotal information is valuable to an assessment, it is important to validate this information with statistical analysis, whenever possible. The plant's current and archived backlogs have a wealth of information. Audits can be conducted to verify general plant feelings about issues such as inventory accuracy. Field observations are essential.
- **Calculate Savings -** In order to proceed with any improvement project, it is imperative to prove its value to the organization. Creating the changes that are discussed in this document is difficult and time consuming. However, they also provide great economic benefit to the organization. While this may be intuitively apparent, it is necessary to provide a specific return on investment for the improvement effort in order to ensure support from all levels of the organization.
- **Plan Next Steps -** Now that the research has been done, how will the organization proceed? Often, companies invest in assessments without a clear idea of how they will move forward. The result is another well written document that gets filed away and employees that are disappointed that they have had to participate in "just another program." An assessment is only the beginning of an improvement effort. It provides the opportunity to prepare a specific, goal-oriented plan for moving forward.
- **Document Results -** As mentioned in the previous step, assessments generally produce documented results. This document should be clear and concise and yet thoroughly capture the information gathered during the assessment. It will become an essential reference for the improvement effort and is also a tool for the next step.
- **Communicate Results -** Once the assessment has been completed, communicate the results to all plant members and to any other stakeholders in the organization. Many of these people have participated in interviews, surveys and other information gathering. They are interested

in the results and want to know how they will be used. This is an opportunity to build enthusiasm and understanding for the coming effort. Sharing the results will help form a common vision of what the plant's current state of operating is.

Step 4. Organization Alignment to Support Change

Once an organization has examined its basic beliefs, accepted external reality and acknowledged what doesn't work, it must create a vision for the organization. This is best done with a participative approach to identifying what the organization could be, envisioned through the efforts of a cross-level, cross-functional representation of employees. Achieving a bought-in vision of what "better" looks like. Next, an organization must dis-empower what has become (or always was) counterproductive. Organizations always get what they reinforce and reward, even if unconsciously. Effective change requires understanding where and how self-limiting beliefs and counter-productive work practices exist, then intentionally dismantling that support. It is here that clarity about the future is achieved, consensus to improve is solidified and commitment must be unwavering.

The challenges of Organization Alignment are:

- **Overcoming cultural barriers -** Organizational change requires that cultural barriers are first unconcealed and recognized as the obstacles that they are. The barriers consist of anything that inhibits the organization from achieving the desired results. This is no easy challenge since a barrier may be the outgrowth of a particular leadership style.
- **Disarming outmoded beliefs -** Organization's will frequently conduct themselves in a mode that is consistent with a condition that was true years ago but hasn't been questioned since that time. Common practice, policies and procedures have been adopted that reflect that outmoded belief. The organization accepts the condition as being valid or the connection to the past condition has been long forgotten and the practice persists. These outmoded beliefs may be significant obstacles to finding innovative ways to working more effectively.
- **Defining what better looks like -** Much of the literature and common wisdom of the organizational change process emphasizes the role of vision in helping an organization create its desired future. What is essential in the visioning process, and neglected in most change processes, is an examination of the organization's basic beliefs and assumptions. When an organization's belief system is not identified and explicitly understood, organizations typically remain unaware of the fact that their beliefs do not support their plans. Consequently they cannot mobilize the resources and commitment levels necessary to bring about change. What needs to be included in the vision process is a visioning of their beliefs and an explicit statement of the forms in which these will manifest. That is, a clear statement of what "better" looks like.
- **Sharing the vision -** Organizations begin by defining what "better" looks like, but this is typically a vision that is held by relatively small group within the organization. Thus, the challenge becomes how to effectively communicate the vision so that more people see the wisdom in making changes. Sharing the vision is no small task and therefore the tendency is to bypass it and move directly to implementing change. Don't! Remember that the changes being proposed by the vision will likely affect everyone, their willingness to participate is directly proportional to their sense of fairness in how the new practices were developed.

There are three conditions that drive organizational change. They are clarity, consensus and commitment:

Clarity: Universal understanding of where we are now, where we want to go and how we are going to get there

Consensus: General agreement (not unanimity) on the clarity items

Commitment: **Reality**; real dollars, real hours, high-quality people

Priority; forsaking other important tasks to make change happen

Perseverance; staying with the program, not caving in to resistance

When these conditions exist, an organization's potential is boundless. Every phase of your improvement approach should revolve around creating or maintaining these conditions. The assessment phase is an important beginning. People need to take a hard look at what they do, and do not, do well. But the implementation phase is where real change is achieved. To be real, new behaviors must be institutionalized, they must become the new status quo. Organization Alignment involves employees in defining and generating change. The result is a change process that is faster, smoother and longer lasting.

The Steps of Organization Alignment can Include

- **Organize Change Team -** Whether you call it ownership or buy-in, empowerment or involvement, significant lasting change is built on a foundation of employee belief in a goal and a way of achieving the goal. To develop coherent, unanimous beliefs we recommend forming a medium-size team (12-15 people) made up of managers and peer group leaders from every department, area and organizational level. This team develops a framework for the organization's work management process. This is the foundation for the "process," the technical side of change management. The team also develops an organization-specific Vision, Mission and Values. This, along with the realization that everyone, at every level and in every department, has the same basic values, is the foundation for the "culture," the people side of change management.
- **Establish Frame of Reference -** This common frame of reference has already been begun with the assessment process. At this point, the members of the change team communicate their frame of reference to the other members. While the organization as a whole knows every detail of the current state of affairs, each individual only knows their part and can truly only conjecture about issues affecting others. Understanding and accepting that fact is fundamental to successful change.
- **Deconstruct Current Process -** An assessment will get your employees thinking about the reality of their current processes. This step actually asks them to pick them apart to finest details. What are the strength and weaknesses of the planning and scheduling processes? What tasks do we perform just because we have always done it that way? Do they make sense anymore?

- **Design Preferred Work Process -** Now that you've pieced apart your current processes, you can put them back together as you want them, with only the best pieces from the old and adding new ways where gaps exist. Organization Alignment also includes defining roles, responsibilities and relationships, and developing a management control process (measurement and reporting).
- **Identify Obstacles to New Process -** What are the impediments to lasting change? Are they procedural? Cultural? Does the plant have the required resources? The right tools? It is important to understand the obstacles so they can either be eliminated, avoided, or accepted and planned for. If everyone is aware of them in advance, they won't seem insurmountable later.
- **Define Preferred Work Culture -** As important as what you want to accomplish is how you want to accomplish it. The challenge of organizational change lies not in the mechanics of making change, but in addressing the cultural norms that define the current organization. The challenge comes, in changing the organizational content (culture) in which the work processes exist. Finally, it lies in aligning every aspect of organizational endeavor with the business mission and institutionalizing these effective alignments.
- **Identify Out-of-Sync Conditions -** On both the process side and the culture side, the change is based upon the difference between what the organization is now and what employees want it to be. We call this defining "what better looks like." The differences are called "out-of-sync conditions" and they are addressed by "action teams" chartered by the change team.. These items may be either process or culture related. Regardless, they are not in keeping with how the organization wants to conduct itself in the future.

Step 5. Define Implementation Plan

Once again, as each of these steps concludes, they are not complete until a plan for moving forward has been developed. At this point, the organization is excited about the future. A new vision for success has been defined and people are ready to enact it. Use this energy and the new found expertise of the Change team members to create a specific and detailed plan for making the vision a reality.

Communication will be important as the implementation plan is developed. Let the plant employees know what the Change team has been working on. Let them share in the excitement and understand where the organization is heading. It is reasonable for people to feel skeptical or nervous when they are told change is coming but are given no information about how, when or of what nature.

Step 6. Implement

The sixth step then is to begin to make the changes defined and illuminated in the previous two steps. The key to success in this step lies with creating a system of accountability. The vision defined in the previous step starts to become reality here, but it isn't sufficient to just implement new procedures. It is necessary to implement more effective roles, responsibilities, relationships and rewards. This step is ensuring that the overlap of responsibilities is minimal and that gaps in coverage are non-existent. It is aligning what employees do with the organization's business

mission and making sure there is clarity, consensus and commitment to realize the full benefits of making organizational change.

The Challenges of Implementation are

- **Organizational involvement and communication -** Actions in support of the new vision may be simple, clear steps or they may be complex strategic initiatives. In either case, they need to be seen and experienced by all members of the organization so that the actions can serve a symbolic as well as a practical purpose. Imposing change on the organization without letting the workforce, that must execute the new practices, have a say in what those practices are, will violate all sense of fairness and will ultimately sink the improvement effort. Communication is another important aspect to employees perception of fairness; what progress is being made and the reasoning for certain decisions will help keep employees involved.
- **Constructing a system of accountability -** Accountability is no more a one man job than is quality. If accountability is the province of an individual, it is personality-dependent and it will rise and fall with changes in personnel and position. An organization must establish a "system of accountability" that begins on the plant floor and extends from department to department and from the plant to corporate. One purpose of a system of accountability is to prompt and encourage people to keep their promises to each other. We all live in a web of promises-implicit and explicit. At work, other people depend on us for information, goods and services, just as we depend upon them. We each promise to provide what others in the organization need to be effective in their jobs. Accountability monitors whether those promises are being kept and reminds us to hold up our end of the bargain. When we all keep our promises to each other the result is human reliability, and with human reliability you can accomplish anything. The second purpose of a system of accountability is to instill discipline into a process. Management processes require discipline, that is, the ability to consistently repeat good practices. Once you've designed and installed a process, you must maintain it. That is as true for management processes as it is for production processes. What usually trips people up is details, the small stuff. A system of accountability organizes and stores all the big and little things you must do to keep your process running.
- **Changing behaviors -** People don't immediately change their behaviors just because the plan says that is what they are supposed to do. Employees behaviors are rooted in their past experiences both at work and in their personal lives. Having a set of values that define the desired behaviors is one element to changing them. Another element is having clearly defined roles, responsibilities and expectations for every individual. However, this still doesn't make behavior change easy, it merely establishes the framework for acceptable behavior. The key to behavior change begins with an explanation of the benefits, followed by continual reinforcement of acceptable behavior and taking corrective action against unacceptable behavior.
- **Problem solving -** Effective problem solving is not regularly practiced in most organizations. When it does occur it usually relates to solving technical problems that an organization with an engineering background is adept at doing. The primary challenge then is to become effective at solving managerial problems. These are the problems that, left unresolved or resolved improperly, fester to create mistrust of an organization's leadership.

Managerial problems are the ones that affect individuals perception of fairness and the respect with which they are being treated.

The Steps for Implementation Include

- **Organize the Effort -** Use your change team as a steering committee for the improvement effort. Determine the methods you will use and the resources required to achieve your results. Prepare a long-term project plan. Set long-term and intermediate goals. Prepare a communication plan.
- **Set Key Performance Indicators -** Setting goals means more than simply saying, "Get better." It means establishing measures for those work management and operating processes that indicate the health of your organization. Report on these measures frequently and widely.
- **Prioritize Initiatives -** Decide what efforts will bring the most rewards and concentrate your efforts on those first. They may be the most difficult and time consuming, but ultimately they will provide the most rewards.
- **Charter Action Teams -** Using the list of highest priority policies and procedures to be addressed, develop a list of action teams, each of which will be assigned one of these issues to discuss and resolve. Provide the team with specific objectives to be met, timeframes for meeting and deadlines. Put together a team of no more than eight members that represent different levels and functions in the plant that have considerable information about or interest in the topic. While many programs recommend employee involvement to increase buy-in and empowerment, they often fail to effectively capture and use the energy and information of the employees. The framework of the action team method will provide structure to the involvement and will empower the members to achieve real results.
- **Review Recommendations -** Use your change team/steering committee to review the efforts of your action teams. Are they in keeping with the processes developed by the change team? Do they reflect the desired work culture? Are they complete and feasible? Chartering action teams is a method for allowing employee involvement, but a plant can't be run as a democracy. Management intervention is still required to ensure that the operation is conducted as a well-run business.
- **Implement New Practices -** Finally, the time comes to put the vision into practice. This may be the most difficult step of all. It is fun to dream. It is easy to imagine how we want things in an ideal world. It is hard to change habits of an entire organization of individuals. Training and coaching are key. The more that this can happen on the job, in the field the more likely that new habits will become ingrained.
- **Clarify Roles and Responsibilities -** Implementing new processes means that most employees roles and responsibilities will change in some aspect of their job. Part of implementation is coaching employees on their own new roles as well as what they can expect from others. It is impossible and unfair to hold employees accountable for new responsibilities that have not been well communicated.
- **Monitor and Adjust Processes -** As you progress, you will find that some ideas worked better than others. Implementing one process changes the way another one functions. As time passes, continue to assess the health of the overall processes and adjust as necessary.

Reinforce and Continuous Improvement

Implementation must always include some means to measure change, whether it is process changes, attitude changes or results changes. Reinforcement then is the application of the measurements to reveal new areas of opportunity for the organization. If, for example, the implementation has not produced the desired level of changes, this should start the process over again to examine what's preventing full realization of the desired outcome. If, on the other hand, results exceed expectations, there may be more, as yet unexplored opportunity in this organizational area. In any event, this measurement and analysis part of the process and the restart of the self-examination process are the very essence of continuous improvement. Remember that there is no permanent goal. There is always "better". Reinforcement is the continuous testing of the organization's clarity, consensus and commitment to be better.

The Challenges of Reinforcement are

- **Continuous improvement -** This is not a program, but a way of life. The measurements that were installed during Implementation must be used to drive improvement activities that are never ending. There will always be opportunity for improvement in any process because there is constant change in industry and society. The challenge is first to adopt this way of life and then to stay focused on the word "improvement"; continuous improvement cannot become a euphemism for retribution. Employees willingness to participate in continuous improvement activities will be dependent upon their efforts achieving results and not being punished for problems with the process.
- **Keeping the vision -** It's bound to happen, slowly the emphasis on the improvement initiative begins to wane. The Implementation is over and results are being realized, so why make any further investment in the program? Chances are that the vision has not been fully realized and/or some backsliding has occurred, therefore there needs to be an ongoing champion(s) of the process to ensure it will realize its full potential. Safety programs typically serve as good models of improvement efforts for which the vision persists despite the distraction of other organizational initiatives.
- **Recognizing success -** Because the change process can take months, sometimes years to achieve, it is easy to forget where the organization came from. This is especially true once the organization is into the Reinforcement step because the pace of change is slower and the effects less evident to the whole organization. Throughout the organizational change process it is critical to recognize the progress that has been made, to recognize team efforts and celebrate the results.
- **Institutionalized change -** Change will be institutionalized when the new practices are referenced as "this is just the way we do things". This becomes the ultimate challenge in the organizational change process. Employees accept and support new practices because they see the benefits and know how their contribution supports the whole.

The Steps for Reinforcement are

- **Re-Discovery -** It is important to continuously review your progress to ensure that the new processes are still strongly in place. Many organizations implement new methods and then backslide once the implementation phase is over. Old habits return. Periodic re-assessments will determine if this is happening.
- **Review Key Performance Indicators -** Continue to review the key indicators to establish the level of process health. These measures are a continuing communicator of the success of the improvement effort. How are they trending? Do they continue to indicate success or is more work needed?
- **Validate Progress -** Just as it was important in the assessment phase to show the value of an improvement project, it is critical to your organization to prove the ongoing value once the implementation phase is complete. Again, anecdotal evidence is worthy of note, most particularly in cultural improvement. However, hard data indicating improvements such as backlog reduction, heat rate reduction or increased availability will validate project success.
- **Recognize Successes -** The improvement project has been a tremendous amount of work and likely caused a certain amount of stress for members of the organization. All along and at this point, remember to recognize and appreciate the gains that have been made. Give group and individual rewards for successes. Appreciate the effort that has gone into making the changes.
- **Facilitate Problem Solving -** There will likely be some areas where the plant has fallen down in its efforts to improve. There will also be areas where expectations have been exceeded and you are ready for the next level of improvement, perhaps a Reliability Centered Maintenance program. Either way, identify those areas and use the change team/steering committee to create solutions for those problems.
- **Determine Next Steps and Goals -** Always determine what the next steps will be. Never leave a phase of the project without determining what the next will be. That is the key to continuous improvement.
- **Communicate Results -** Communicate, communicate, communicate. It is the only way to keep employees interested and bought-in and the only way to avoid fear and skepticism.

Resistive Elements

When implementing change in the organization to move from reactive to a planned environment, certain resistance occurs that could possible debilitate the change effort. Resistive behaviors will be present in all parts of the organization-from the front line worker to the plant management. Typical behaviors that may be encountered are:

- “There is not enough time in the day to do planning and scheduling”
- “Our priorities change even on an hour by hour basis let alone a day to day or week to week basis”
- “There are too many emergencies for us to have meaningful planning and scheduling”
- “There is no budget to fix things properly anyway”

- “There is far too much paperwork”
- “Parts are never available”
- “We do scheduling already as far ahead as we need to”
- “We don’t have the resources to do Planning and Scheduling...we have no planners..”
- “Maintenance may plan all they want, but operations will tell us what we are going to do today...”
- “We do not have the leadership or discipline to do planning and scheduling..”
- “We are already working as hard as we can, we can’t do any more..”
- “Emergencies are more fun and important than preventive activities..”
- “You can’t plan and schedule in the utility industry”

Management must recognize these resistive elements in the behaviors of their workers and in themselves. There can be no excuses to achieving the goals of planning and scheduling, and management cannot accept excuses.

Reactive - the Natural State

In the absence of discipline from management processes, all activity at a plant will be in reaction to emergency conditions. There is no concern for items that haven’t become emergencies and aren’t demanding attention. Decisions must be made in emergency situations-decisions should be made in preventive situations. Those “should” decisions are often overlooked when the managing gets tough in an organization. Planning and Scheduling is a “should” process that requires management’s vigilant attention to keep it a “must” process. Failure by management to give planning and scheduling its vigilant attention will result in the organization opting for the “must” work from emergency work. If management does not give planning and scheduling the discipline it requires, the organization will find itself drifting towards becoming more and more reactive.

8
THE BIG PICTURE

In simple terms Plant Maintenance Optimization (PMO) is moving the maintenance program from a “reactive” philosophy were maintenance is performed as a result of unexpected failures, to a “planned” approach were maintenance is performed at the most optimum time and often times before equipment failure. Reactive maintenance is more costly and has a negative impact on plant availability, while PMO is more economical and significantly improves plant availability. PMO also optimizes the existing planned maintenance activities at a plant.

PMO answers four basic questions. What will a plant do differently in its maintenance program? How will a plant carry out the specific maintenance tasks? Who will do the work? What advance tools are available to do the maintenance work?

For a successful PMO program the following needs to be addresses:

- Advanced Maintenance Strategies: These strategies address what maintenance approaches will be taken to move the maintenance program from reactive to planned. Such approaches include, optimizing the maintenance basis, implementing predictive maintenance program and developing a living proactive maintenance program.
- Work Process: This part of the PMO process addresses the how maintenance is accomplished. It examines the work process from work initiation, to planning g and scheduling, to work execution, to work completion and finally to continuos improvement.
- People: Skills, Work Culture, Management: For maintenance optimization to be successful it requires a well-trained work force, good management and an organizational structure. A work culture that is respective to new ideas. This aspect of the PMO approach focuses on who does the work.
- Tools/Technologies: This category of PMO focuses on the tools required to support the staff. There have been significant advancements in technologies, which can help an organization meet its availability and budget goal.

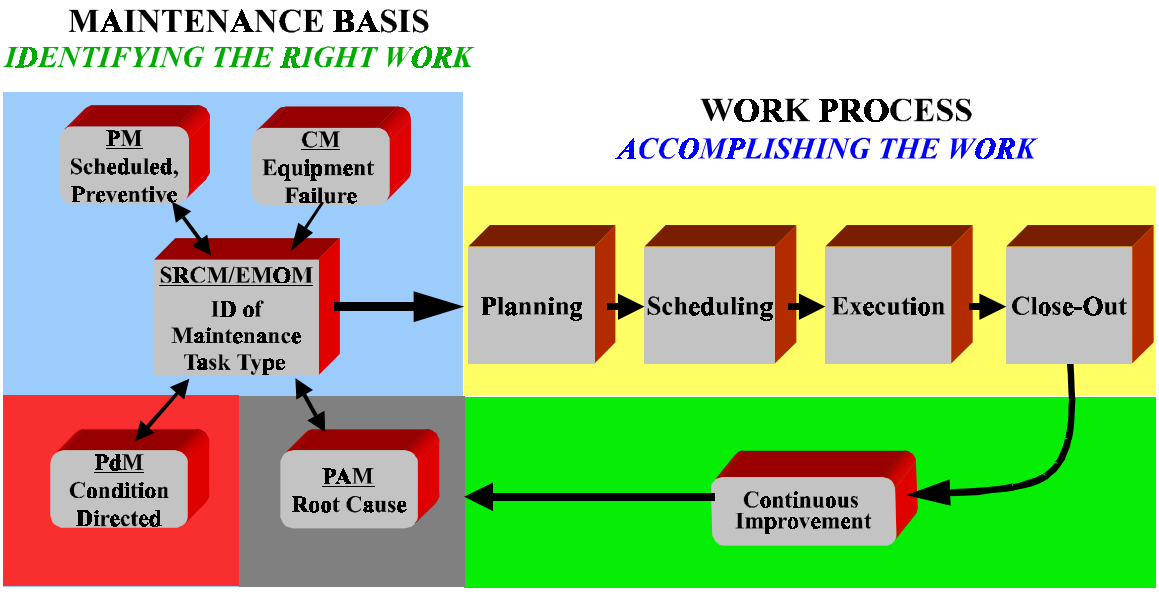


Figure 8-1
The Maintenance Process

This Figure 8-1 illustrates the major initiatives that are required to fully incorporate the PMO process. It shows the key approaches used to identify work at a plant by managing the maintenance basis and identifies the ingredients for how this work gets accomplished through the work process, and this figure also shows how planning and scheduling steps fit into the PMO process.

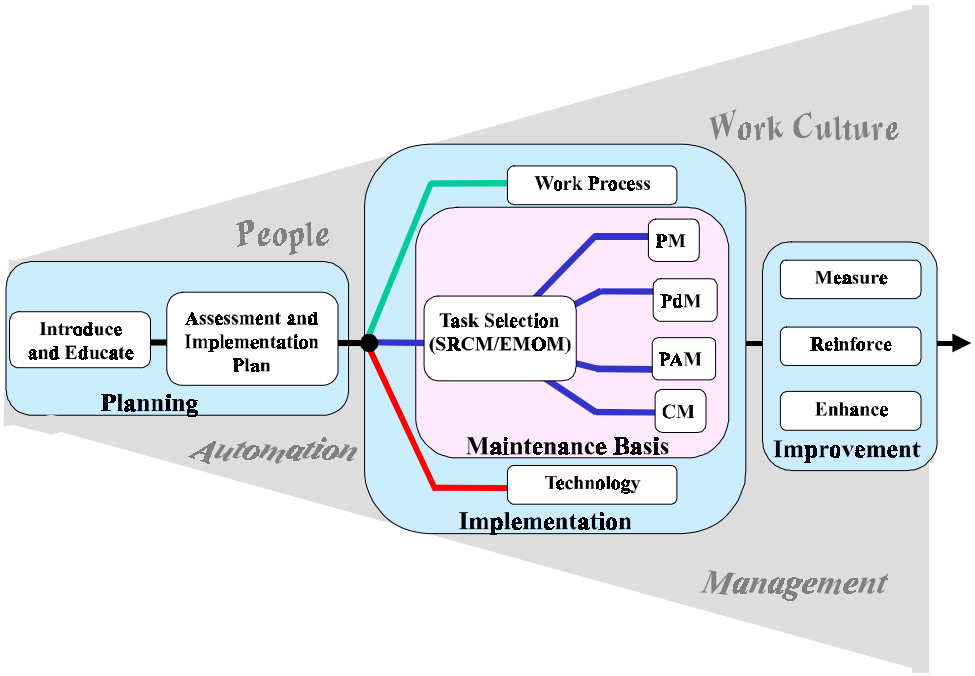


Figure 8-2
The Improvement Process

The Plant Maintenance Optimization implementation road map is shown above in Figure 8-2. It covers the major implementation steps of planning, implementation and improvement. This figure illustrates how staff, management, work culture and technology permeates all aspects of PMO.

Strategies

A number of maintenance strategies are being utilized in industry today and these fit into the following categories:

- **Corrective/Reactive Maintenance (CM) -** Corrective maintenance (a.k.a. Fire Fighting, Breakdown Maintenance) is failure based. Often times this strategy, when applied to critical equipment, leads to catastrophic failure causing a loss of production. Most Power Producers today relay heavily on this strategy. Although it is important to move beyond the reliance on Corrective Maintenance, there still exists a place for this strategy in the overall maintenance plan. Certain systems and assets simply lack the criticality to justify Preventive, Predictive, or Proactive action. A sensible approach helps to identify when this is the case, which prevents squandering resources on these lower priority assets.
- **Preventive Maintenance (PM) -** Performing a task on a time or interval basis in an effort to avoid catastrophic failure is referred to as Preventive Maintenance. This strategy offers the efficiency of performing maintenance tasks on a planned rather than reactive basis, thus avoiding the losses associated with unplanned downtime. However, the penalty of PM is that many times maintenance is performed that is unnecessary and costly.
- **Predictive Maintenance (PDM) -** Basing maintenance of assets on equipment condition represents yet another step improvement in effectiveness. A weakness of Preventive Maintenance is that most assets are either over maintained or under maintained - rarely is action taken at exactly the optimal time. Alternatively, PDM relies on employing technologies to understand the current condition of assets so that only required maintenance is performed, and it is done on a planned basis.
- **Proactive Maintenance (PAM) -** Any asset, whether being maintained using PM, PDM, or CM, that continues to demonstrate unacceptable reliability should be considered a candidate for a PAM investigation. PAM is a study that determines the root cause of the problem. Chronic problems warrant the application of advanced technologies, additional resources, and time to fix the problem “once and for all”. The problem could be the result of poor design, maintenance, or operating procedures.
- **Reliability Centered Maintenance (RCM) -** This conceptual exercise identifies the most effective and applicable maintenance tasks for each piece of equipment. This task selection defines the Maintenance Basis (optimum mix of CM, PM, PDM, PAM). A full classical RCM study involves an exhaustive investigation of all failure modes and their effects. This approach, however, has now been streamlined by EPRI for the utility industry. This streamlined RCM includes the investigation of common, known failure modes and the analysis of the resultant effects, as well as the determination of effective and applicable maintenance tasks to address those modes.

- **Equipment maintenance Optimization Manuals (EMOMs) -** This strategy works in conjunction with the RCM approach. In addition to the RCM task selection, EMOMs include task cost justification, equipment work packages and maintenance procedures.

Maintenance Basis

The maintenance basis is established using the RCM/EMOM strategy. This approach determines the proper mix of CM, PM, PDM, PAM tasks. This process includes:

- * Rank the plant systems and equipment
- * Determine the failure modes and causes
- * Select tasks (CM -run to failure, PM, PDM, PAM) that addresses the failure modes
- * Capture the operations and maintenance procedures
- * Capture standardized work packages

Predictive Maintenance (PDM)

PDM is performing maintenance based on the condition of the equipment. PDM is more extensive than applying just the technologies for machinery condition monitoring and diagnostics. To be completely effective, PDM also includes other related items pertaining to a particular machine or component, such as: historical maintenance data, operator log information, test records, and even design considerations. As a result, a PDM program will require support form all plant groups, specifically, maintenance, operations, technical and management. The process includes:

- Determining roles and responsibilities
- Establishing the PDM Work Process and how it fits into the plant work process
- Determining the equipment that will be in the program and the condition indicators (i.e. condition monitoring technologies, equipment efficiency monitoring, process data, batch testing, operator rounds and logs, maintenance histories, observations from operations and maintenance and design data) that will be used to determine the equipment condition.
- Establish channels of communication
- Preparing a condition assessment report
- Establishing and measuring the Return on Investment and Cost Benefits
- Establishing and tracking continuous improvement metrics

Work Process

The Work Process part of the PMO Process (Figure 8-1) covers, planning, scheduling, work execution and work close-out. It is here in the work process where Planning and Scheduling fits into the overall process of maintenance optimization. Planning and Scheduling covers:

- Back Log Management
- Work Packages
- Parts availability (Stores/Inventory)
- Parts staging
- Daily Schedule
- Multi-week Schedule
- Outage Schedule
- Tracking planning accuracy
- Tracking Schedule Compliance

If a comprehensive PMO program is implemented, emergency and urgent work should be reduced. Schedule compliance is necessary in order to maintain this 'planned' approach to maintenance. The Work Execution element of Work Process cover the following:

- Man-hour Utilization
- Staff Training
- Tools Availability
- Tool Upgrade to Latest Technology
- Track Rework vs. Total Work
- Track "Wrench" Time vs. Total time

Work Close-out element of Figure 8-1 captures:

- Obtaining detailed maintenance histories
- Addressing post maintenance testing
- Reviewing work orders with the intent of eliminating work in the future
- Feedback to the origination of the work orders

Continuous Improvement

It is important to establish a continuous improvement process, which has a feedback loop. This process determines what type of work was performed, could it have been avoided, and what steps should be taken to eliminate it. This process covers:

- Categorize Work Orders ("good" vs. "bad") Good work orders are a result of the maintenance basis tasks. Bad work orders are urgent or emergency work orders and work that are unexpected (not resulting from the maintenance basis tasks.
- Root Cause Analysis.
- Determine the Failure mode and cause.

- Modify the maintenance basis.
- Review periodically the "good work orders" and modify the basis as needed.
- Track work order types.

People: Skills, Work Culture and Management

Because the people involvement is critical to the work process, individual participants should be the best qualified which includes the full spectrum from adequate training of the technical personnel doing the work, to plant and corporate management sponsorship. If management sponsorship is not their, then the PMO implementation should not continue.

A major part of the PMO Implementation is focused on the work culture and plant organization. The culture needs to be addressed so that the plant personnel are prepared and receptive to the changing maintenance philosophy. A work culture that is open and eager for change is a foundation for all other process and technology improvements in PMO.

As described earlier, the work culture (or work environment) is as manageable as any other part of the business. In essence, addressing your work culture is management - you don't manage equipment, you manage people. Your work culture is managed the old fashioned way, by setting expectations and making sure people live up to them. We call it making and keeping commitments. The commitments are made in a well-defined work management process and they are lived up to in as system of accountability. Accountability is the "latch" that keeps process and work culture aligned.

Tools/Technologies

The basic technologies for the start of a beneficial PMO program are vibration, thermography, and oil analysis. Once implemented, other technologies such as acoustics for mechanical and electrical problems, as well as leak detection, not only enhances the program by adding additional useful information regarding the condition of a piece of equipment, but other technologies such as these verify the suspect of a problem.

In addition, some technologies are equipment-specific and are extremely valuable to determine the condition of a machine. For example, periodic testing of high voltage electric motors for winding resistance, capacitance/dissipation factors, insulation resistance, etc. can uncover potential problems that the basic technologies may not.

Automation is becoming essential for a successful PMO Program. The automation of the control system (DCS), computerized maintenance management system (CMMS), the integration of all condition indicators, and reporting and history capture is becoming essential.

A
APPENDIX A

Acronyms

Table A-1
Acronym Descriptions

Abbreviations	Description
CBM	Condition Based Maintenance
CM	Corrective Maintenance (Work Order)
CMMS	Computerized Maintenance Management System
EFOR	Equivalent Forced Outage Rate
PAM	Project or Proactive Maintenance (Work Order)
PCM	Profit Centered Maintenance
PDM	Predictive Maintenance, for work order PDM refers to condition directed work
PM	Preventive Maintenance (Work Order)
PM Basis	Basis documentation for required PM's
PMO	Plant Maintenance Optimization – EPRI Target Name
PMT	Post Maintenance Testing
RCA	Root Cause Analysis
RCM	Reliability Centered Maintenance
P&S	Planning and Scheduling

Definition of Terms

1. Backlog - Backlog is all assigned* work orders that include CM's, PDM's, PAM's, all due PM's, and all overdue PM's.

   Backlog is described in terms of hours, gross weeks to execute, and projected schedule duration - for both online and offline.

Table A-2
Backlog Values

	Backlog Hours	Weeks to Execute*	Projected Schedule Duration **
Online	10,000	4 Weeks	8 Weeks
Offline	25,000	9 Weeks	4 Weeks
Total	35,000	13 Weeks	12 Weeks

Backlog can be expressed plant wide, by unit or by area.
*Assume total Labor resource complement is applied.
**Assumes expected weekly resource complement is applied. (resources + OT + Contractor)

2. CBM or PDM - Condition Based Maintenance or Predictive Maintenance: A process which requires technologies and people skills, while combining and using all available diagnostic and performance data, maintenance histories, operator logs, and design data to make timely decisions about maintenance requirements of major/critical equipment.

3. CM - Corrective Maintenance: Corrective repair tasks on equipment that has failed and lost its functionality. CM's will also include failures on designated "run to failure".

4. CMMS - Computerized Maintenance Management System: A software package designed to assist in managing the maintenance function.

5. EFOR - Equivalent Forced Outage Rate: An industry metric for measuring reliability taking into account total and reduced load events. Forced is undesirable, emergency and unplanned events.

6. Equipment Owner - Equipment Owner refers to a component specialist, whose components may extend through several systems. The owner would be so designated as the "go to" person for that component. An example would be the valve specialist, or motor specialist, or pump specialist.

7. Net Available Man-hours - Total Manpower less non direct work time such as sickness, vacation, training, and meetings.

8. PDM task - Condition directed tasks (Planned Maintenance) on equipment where degradation has been detected and action is warranted to prevent functional failure.

9. PM - Preventive Maintenance: Maintenance tasks carried out at predetermined intervals, including PDM routes, and intended to reduce the likelihood of a functional failure.

10. PMT - Post Maintenance Testing: Equipment tests performed following maintenance tasks and prior to returning the equipment to service for the purpose of gathering quality and base line information.

11. PAM -Proactive tasks such as projects resulting from root cause analysis efforts. Proactive tasks are performed to provide enhanced benefits such as reduced maintenance costs, improved reliability or improved performance.

12. Priority: A rating system to establish precedence by order of importance or urgency.

13. PMO - Plant Maintenance Optimization achieves the appropriate investment balance of Corrective (CM), Preventive (PM), Predictive (PDM), and Pro-Active (PAM) techniques for maintenance, integrating all diagnostic, maintenance, financial, and process data into the decision making process.

14. RCA - Root Cause Analysis: A technique used to discover the true reason for an equipment or asset problem, malfunction or breakdown.

15. RCM - Reliability Centered Maintenance: RCM reviews the design of each system and postulates a set of failure modes based upon an assumed failure of each component (and sub component) in the system. Based on the assumption, all possible outcomes are postulated and a maintenance program formulated.

16. Streamlined RCM - EPRI's streamlined approach to traditional Reliability Centered Maintenance analysis.

17. Work Order Categories - the acronyms above are combined to identify categories of work on work orders. A typical set of work order categories and sub-categories are:
    CM, Corrective Maintenance
        CM-RTF, Run To Failure (acceptable work)
        CM-CBM, Condition Based Maintenance (acceptable work from PM, PDM or PAM)
            CM-CBM-P1 & P2, Priority 1 & 2 (undesirable work)
        CM-U, Unplanned (undesirable work)
    PM, Preventive Maintenance
        PM-PDM, Predictive Maintenance data collection tasks
        PM, all other PM work.

Target:

Work Process Improvement Guidelines & Techniques

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EPRI creates science and technology solutions for the global energy and energy services industry. U.S. electric utilities established the Electric Power Research Institute in 1973 as a nonprofit research consortium for the benefit of utility members, their customers, and society. Now known simply as EPRI, the company provides a wide range of innovative products and services to more than 1000 energy-related organizations in 40 countries. EPRI's multidisciplinary team of scientists and engineers draws on a worldwide network of technical and business expertise to help solve today's toughest energy and environmental problems.

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