

Table of Contents

Lesson One	The Need for PM.....	3
Lesson Two	Setting Up a PM Program.....	19
Lesson Three	Scheduling PM.....	37
Lesson Four	Controlling Work.....	53
Lesson Five	Quality Control.....	71

PREVIEW
COPY

© Copyright 1981, 2010 by TPC Training Systems, a division of Telemedia, Inc.

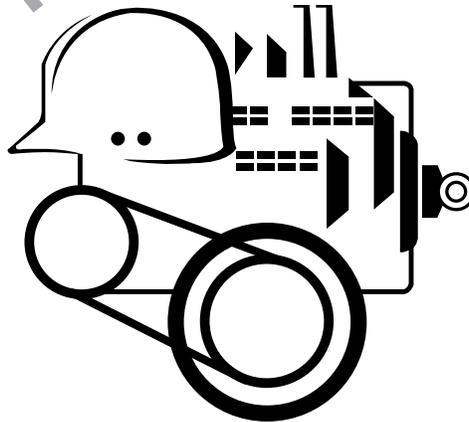
All rights reserved, including those of translation.

Printed and videotaped courseware are subject to the copyright laws of the United States. You are not authorized to make any copies of this material. If you do, then you are subject to the penalties provided under the copyright law, which include statutory damages up to \$50,000 for each infringement of copyrighted material, and also recovery of reasonable attorneys' fees. Further, you could be subject to criminal prosecution pursuant to 18 U.S.C. § 2319.

IMPLEMENTING PREVENTIVE MAINTENANCE

Lesson One

The Need for PM



TPC Training Systems

90201

Lesson**1*****The Need for PM*****TOPICS**

The Scope of PM
Good Programs Pay Off
Costs Cut Dramatically
Inspections
Establishing Maintenance Routes
Steps in Planning

Review
Decide
Implement
Maintenance Job Orders
Priorities
Scheduling

OBJECTIVES

After studying this lesson, you should be able to...

- List the six functions of a typical PM program.
- List the major benefits of PM.
- Explain the three stages involved in the planning process.
- Describe the function of the maintenance job order.
- Explain the use of a priority system.

KEY TECHNICAL TERMS

Nondestructive testing 1.11 a technique that tests an item or material without damaging it
Maintenance job order (MJO) 1.34 a document authorizing work to proceed

Long-range scheduling 1.47 pinpoints a time six weeks to one year in the future when a major maintenance task will be started
Short-range scheduling 1.48 guides the workload for one to two weeks into the future

The major purposes of preventive maintenance are simple: to save time and to cut costs. Other goals include reducing losses, improving product quality, boosting production efficiency, and increasing profits—benefits with which no one is likely to quarrel.

Basically, preventive maintenance consists of sound planning, effective scheduling, competent inspection, and adequate follow-through. Some maintenance personnel seem to think that these goals are difficult—if not impossible.

The purpose of this lesson is to show you that good preventive maintenance isn't impossible, or even difficult. It also suggests some specific proven preventive maintenance procedures you can implement successfully on the job.

The Scope of PM

1.01 *Preventive maintenance* (commonly called *PM*) is important because it helps prolong the life and increase the reliability of equipment and facilities. Because scheduled inspections catch potential problems early, emergencies are few. Downtime and other costly delays are held to a minimum.

1.02 A typical PM program usually involves six functions (Fig. 1-1):

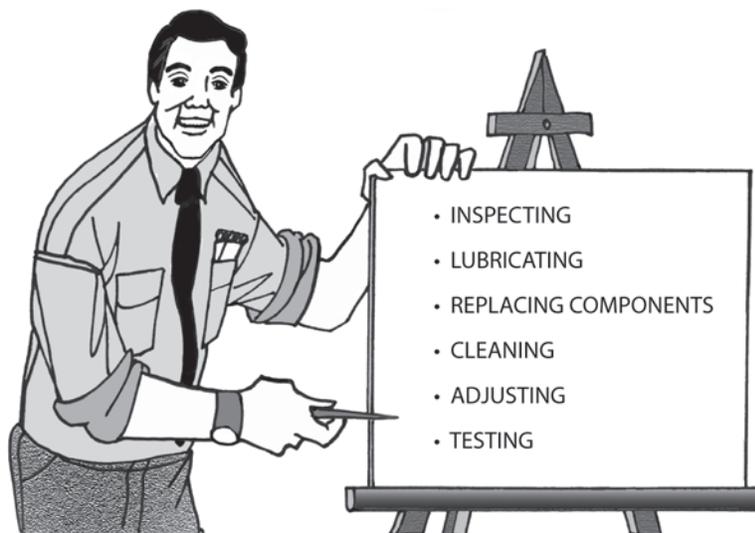
- inspecting
- lubricating
- replacing components

- cleaning
- adjusting
- testing.

But keep in mind that not all functions are required on every job.

1.03 More extensive efforts, such as rebuilding and overhauling equipment, are not usually considered part of PM. They are thought of as actions that must be taken when equipment or facilities have deteriorated to the point at which PM can no longer help. Only when the equipment is brought up to standard again can PM take over and prove effective.

Fig. 1-1. Six major functions of PM



Good Programs Pay Off

1.04 Successful PM programs produce dividends for the maintenance department, as well as for the company. Some of the major benefits include:

- **Fewer breakdowns.** Because problems are identified well before they get out of hand, routine adjustments and minor repairs replace costly downtime.
- **Fewer emergencies.** Maintenance employees as well as equipment operators become alert to situations that are likely to cause major problems. The result is that potentially dangerous conditions are spotted and corrected in time.
- **More efficient work plans.** Timely PM inspections reveal major tasks early and suggest lead times necessary for their successful completion.
- **Less overtime.** With fewer emergencies, there is a corresponding decrease in overtime.
- **Longer equipment life.** Because it is properly serviced and maintained, equipment runs longer and more dependably.
- **Equitable use of manpower.** Emergencies are usually 15% more costly in terms of labor than similar jobs handled on a planned, coordinated basis. PM inspections pinpoint potential emergencies so that you can be prepared for them in advance. Equally important, with a sound PM program, you can plan work to ensure its efficient, economical completion.
- **Increased production/decreased downtime.** You can get better cooperation from production if you stress the advantages of scheduled downtimes. For production, the main advantages are reduced losses due to emergencies, improved productivity, and less overall downtime.
- **Cuts in maintenance costs.** Without an effective PM program, the costs of extra labor due to emergencies must be absorbed by the maintenance department.

Costs Cut Dramatically

1.05 A strong PM program can cut costs dramatically—sometimes as much as 15%. Maintenance crews tend to work more efficiently because they are under less pressure. The result is less wasted motion and more output.

1.06 Experts point out that PM costs will equal about 8% of total maintenance manhours and about the same percentage of total maintenance costs.

1.07 The overall cost of a PM program is equal to about 4% of the equipment's value. The cost of installing an effective PM program equals about 10% of the total savings produced by the program. In general, a well-designed PM program will pay for itself and start showing benefits in less than two years.

Inspections

1.08 One of PM's primary goals is to find conditions that can cause equipment to fail before it breaks down (Fig. 1-2). By minimizing breakdowns, you will be able to plan and schedule maintenance work with the greatest accuracy and efficiency.

1.09 You may not find it practical to inspect every device or piece of equipment in the facility. But you can prevent many production-line problems by concentrating on equipment whose failure can:

- endanger the life or health of personnel
- affect product quality
- cause large losses by functioning improperly.

1.10 The inspection phase of a PM program is designed to prevent such problems. It tells you the status of equipment, and suggests the lead times necessary to plan and schedule repairs and services. Inspections should be *detection-oriented*. That is, they should reveal problems before they become crises.

1.11 *Nondestructive testing* (sometimes referred to as predictive maintenance) is often part of PM inspection. This technique uses sophisticated testing equipment to locate problems that you can't find easily. It tests the item or material without damaging it.

Fig. 1-2. Inspections cut equipment failure and downtime



1.12 Your crew members on inspection may be tempted to correct every fault they find. Desirable as this might be, it takes up time they need to complete their inspection routes and is likely to result in hurried, slipshod inspections toward the end of the day.

1.13 To make inspections as thorough and systematic as possible, start by reviewing the results of previous inspections, noting the following details:

- dates
- conditions noted
- procedures used
- routes employed
- work inspected
- work completed
- reports/records prepared
- follow-through accomplished
- personnel contacted.

1.14 Check out any breakdowns or emergencies taking place since the last inspection:

- What were the causes?
- When did they happen?
- Why did they occur?
- Who or what was affected?
- How were they resolved?

1.15 Evaluate any recent problems or complaints from operators:

- What happened?
- To whom?
- Where?
- When?
- With what frequency?
- How was it brought to your attention?
- Results?

1.16 Determine the priorities of corrective action:

- What areas, facilities, or equipment are involved?

- Must the work be done now? In the near future? Long-range?
- What skills, tools, materials, and equipment are required?

Inspections often provide clues to hidden problem areas.

Establishing Maintenance Routes

1.17 In conducting inspections, concentrate on key areas, rather than becoming sidetracked by every minor problem brought to your attention. The best way to do that is to plan a route that allows you to check all vital production equipment on schedule.

1.18 A well-planned route will also help you eliminate haphazard crisscrossing through the facility. This, in turn, will reduce the chances of your missing something important.

1.19 The following steps will aid in planning a route:

1. Obtain a blueprint or layout of the facility.
2. Pinpoint the locations of maintained equipment.
3. Plot a route that covers all essential equipment.
4. Analyze your route—are there other, more efficient routes that can provide the required coverage?
5. Determine how much time is needed to cover the route. Do you see any shortcuts? What steps can you take to increase the efficiency and effectiveness of the equipment coverage?

Steps in Planning

1.20 Planning is the process used to develop a practical course of action. It offers the greatest opportunity for both immediate and long-term improvements.

1.21 To be effective, planning must be thorough enough so that routine maintenance responsibilities are handled on a scheduled basis, yet flexible enough to bring emergencies under quick control.

1.22 Good planning pays off. A comparison of planned versus non-planned maintenance indicates that planning results in a 12 to 15% saving in labor costs alone. A well-planned maintenance program also gives you fewer production interruptions, lower costs, better quality work, and less time spent per job. The process of developing a plan can be broken down into three stages: review, decide, and implement.

Review

1.23 Review the conditions affecting maintenance operations in your company. Such a review can give you valuable insights into your maintenance operation and the courses of action possible for you to take. The review may, for example, cover areas such as:

- Goals and objectives of the organization, including the contribution maintenance must make.
- Job orders and PM inspection reports with special emphasis on repair histories and reasons for equipment failure (Fig. 1-3).
- Potential problems brought to your attention by production and operations.
- Equipment replacement, rebuilds, and major overhauls.
- Manpower required for PM as well as emergencies.
- Resources available. What additional material and equipment may be needed? How quickly can you obtain them? From what sources? At what costs?
- Budgets to meet routine operational needs, as well as crises.
- Changes by management that affect PM, current programs, budgets, personnel, equipment, and facilities.
- Priorities/schedules previously established and their results. What changes, if any, are indicated? What effect will these changes have on production, maintenance, and operations?

Decide

1.24 When your review is completed, it's time to start making decisions based on the results of your review.

1.25 You can now confidently predict manpower requirements for full-time maintenance workers, part-timers, and even specialists with specific skills.

1.26 You can more accurately estimate material and equipment needs. This includes the quantities and dates required based on the scope of maintenance projects, both routine and special. You are also able to determine any special tools or facilities required for testing, servicing, and repairing the equipment.

1.27 You are now better able to coordinate dates and times maintenance jobs are started and completed. You have time to schedule and determine the length of any facility or equipment shutdowns. You can get any other available sites and equipment ready so that production need not shut down.

1.28 At this point, you might also consider putting in a communication system that links management and production with maintenance.

1.29 You will be able to monitor costs closely to see if they are within budget. If not, can you get additional funds? What will be the additional expense to maintenance?

Fig. 1-3. Checking equipment repair histories



1.30 You now have time to evaluate opportunities and identify potential problems. You will be able to judge their significance and possible effects on maintenance plans and activities.

The Programmed Exercises on the following page will tell you how well you understand the material you have just read. Before starting the exercises, remove the Reveal Key from the back of your book. Read the instructions printed on the Reveal Key. Follow these instructions as you work through the Programmed Exercises.

10 Programmed Exercises

<p>1-1. PM can only prove effective when equipment has been brought up to standard. True or False?</p>	<p>1-1. TRUE Ref: 1.03</p>
<p>1-2. With fewer emergencies, there is a corresponding decrease in _____.</p>	<p>1-2. OVERTIME Ref: 1.04</p>
<p>1-3. You can get better cooperation from production if you stress the advantages of _____ downtimes.</p>	<p>1-3. SCHEDULED Ref: 1.04</p>
<p>1-4. A strong PM program can cut costs by as much as _____%.</p>	<p>1-4. 15 Ref: 1.05</p>
<p>1-5. A technique that tests equipment without damaging it is called _____ testing.</p>	<p>1-5. NONDESTRUCTIVE Ref: 1.11</p>
<p>1-6. While performing PM inspections, crew members should correct every fault as they find it. True or False?</p>	<p>1-6. FALSE Ref: 1.12</p>
<p>1-7. To eliminate haphazard crisscrossing through the facility, you should use a well-planned _____.</p>	<p>1-7. ROUTE Ref: 1.18</p>
<p>1-8. The three stages of the planning process include _____, decide, and implement.</p>	<p>1-8. REVIEW Ref: 1.22</p>

Implement

1.31 You can use the decision step in your maintenance plan to assign priorities to maintenance projects. This, in turn, can help you make sure that labor, tools, and materials are available at times and places where they are needed.

1.32 What's more, your supervision is likely to be better. If you plan maintenance, you will have time to get ready to supervise, time to assign tasks carefully, time to confer with production, and time to train. In general, the more time you spend supervising, the greater your crew's productivity.

1.33 To help you develop and carry through your own maintenance plan, Fig. 1-4 shows a worksheet for a typical plan that you can use as a guide. Because no maintenance plan can cover all cases, feel free to change the worksheets as necessary to conform to your maintenance operation.

Maintenance Job Orders

1.34 A *maintenance job order (MJO)* is a document authorizing work to proceed. Although formats for MJOs vary widely, their functions are similar:

- to describe the work fully
- to estimate needed resources
- to allocate job costs
- to set priorities
- to control job approvals
- to aid scheduling
- to report work progress
- to assign maintenance personnel.

Fig. 1-4. Worksheet for developing a maintenance plan

Review:

- | | | |
|-----------------------|-----------------------|---------------------------------------|
| 1. Goals/objectives | 4. Resources | 7. Manpower required |
| 2. Inspection reports | 5. Budget | 8. Changes anticipated |
| 3. Major jobs | 6. Potential problems | 9. Established priorities & schedules |

Decide:

1. What does the review tell you about your present maintenance operation? _____

2. What action(s) are open to you? _____

3. What steps should you take to improve maintenance procedures, scheduling, cooperation with production, emergencies, etc.? _____

4. What will it cost in terms of time, money, manpower? _____

5. What alternatives should be considered? _____

6. What problems can waylay your plan? _____

Implement:

1. What must be done to put the plan into action? _____

2. What help is required? _____

Fig. 1-5. Typical MJO format

Equipment location (PM route): CHARGE NO. 5 2 7 5 0 6 2

Relates job to area of responsibility: WEEK NO. 0 4

Equipment ID number: EQUIP. NO. 7 5 0 6

Week work was reported: WK. NO. 0 4

Details of work to be done: COMPONENT 1 0 7 1

Work generated as result of PM inspection: PM ROUTE 5 2, PM P

Priority classification: PRIORITY CODE 2

DESCRIPTION (RESERVED FOR PLANNER): R P R CONVEYOR BELT

MAINTENANCE JOB ORDER

DESCRIPTION OF WORK: 40-ft section of belt damaged because of failure to lube and inspect rollers. Replace belt section, resplice or vulcanize, replace rollers.

EQUIPMENT DESCRIPTION: 40-ft section of belt damaged because of failure to lube and inspect rollers.

WORK PLAN: Replace belt section, resplice or vulcanize, replace rollers.

SHUTDOWN SCHEDULED: 0730 FEB. 10

PLANNER: T. Roberts

REASONS FOR FAILURE:

1. Normal use	6. Improper maintenance	9. Accident
2. Material failure	7. Improper lubrication	10. Unknown
3. Improper use	8. Failure to inspect	
4. Improper operation		Above serves as a history for corrective action
5. Blockage		

1.35 A typical MJO is shown in Fig. 1-5. This relatively simple form—used along with your maintenance plan—is a valuable tool in allocating job costs and in recording vital information for future review. This is especially important as situations or personnel change.

1.36 Processing the MJO is quick and easy. First, the MJO is prepared by whoever needs the work done, then approved by the supervisor of that department. All copies are forwarded to the maintenance supervisor responsible for handling the job.

1.37 It is usual practice to have a qualified staff member determine whether the job is justified. That person is also responsible for verifying costs (making

sure the costs are correct and charged to the right department).

1.38 Upon approval, a copy of the MJO is sent to accounting in preparation for gathering material and labor costs. The remaining copies of the job order are forwarded to maintenance. One copy is used for planning and scheduling, the other is given to the maintenance worker assigned to the job.

1.39 When the job is completed, one copy of the MJO is returned to accounting as a closing notice. The job costs are then posted to two copies of the MJO. One copy is returned to the person who requested the work. The other is used to monitor equipment repair costs.

1.40 Reviewing MJOs as you prepare your maintenance plans gives you a:

- way of measuring the effectiveness of PM inspections
- means for evaluating future manpower and material needs
- picture of the reasons certain equipment failed and the steps to bring about corrective action
- review of various crafts within maintenance and possible improvements in their flexibility and productivity
- history for immediate and future corrective actions for specific equipment.

1.41 A summary of the steps in the preparation and use of MJOs is given in Fig. 1-6. You can use it as a guide in preparing and executing your own MJOs.

Priorities

1.42 An effective maintenance plan must consider the order of jobs done and who does them. The aim of the plan is to reduce the workload while concentrating on areas in which emergencies are common.

1.43 *Priorities* define the urgency of jobs. You can use the following categories as a general guide for establishing priorities:

- *Priority One* is emergency work that must be handled immediately to prevent accidents or interruption of production.
- *Priority Two* is scheduled maintenance that must be completed within two weeks, or you risk possible safety hazards, production downtime, or equipment damage.
- *Priority Three* is routine maintenance to be completed within four weeks.
- *Priority Four* is scheduled work to be completed within eight weeks.

Fig. 1-6. Preparing and using MJOs



- *Priority Five* is deferred maintenance that should be completed only as labor becomes available. Typically, Priority Five jobs are fill-in that should be completed within about three months.

Scheduling

1.44 You now know exactly what needs to be done. You have the tools, talent, materials, and manpower to handle the job successfully. But production is involved in scheduling, too.

1.45 Without production's cooperation, you aren't likely to achieve much. The key word is *cooperation*. Unless production is cued in on your plans, it may not be able to shift its workloads and equipment use in time to meet your schedule.

Fig. 1-7. Scheduling is both long- and short-range in scope



1.46 As the term suggests, scheduling helps to make certain the right equipment, materials, and skills are available at the right place and time. Scheduling can be both long- and short-range (Fig. 1-7).

1.47 *Long-range scheduling* tries to pinpoint a time in the future (usually six weeks to one year ahead) when a major maintenance task will be started. A long lead time is necessary to inform production well in advance of the work to be done. This way, you can consider your alternatives in a less hectic atmosphere and reach mutually agreeable decisions calmly and objectively.

1.48 In *short-range scheduling*, you consider the workload for the next one or two weeks. Short-range scheduling serves as a guide for how you will use your resources. You can also use it to signal when work on a long-range project is scheduled.

1.49 With schedules, you will be able to:

- Quickly determine whether or not the job can be fitted into available time and money.
- Analyze a job in detail because you must outline all steps involved, including delivery of materials, special purchases, tool requirements, completion dates, and so on.
- Consider variables and possible alternatives objectively.
- Allocate and schedule manpower efficiently.
- Regularly evaluate on-the-job performance of maintenance personnel.
- Develop a breakdown of costs for future reference.

1.50 Some tips on scheduling tactics and procedures are given in Table 1-1. Tables 1-2 and 1-3 are samples of forms typically used in long-range and short-range scheduling.

Table 1-1. Scheduling tips

Long-range	Short-range
<ol style="list-style-type: none"> 1. Use a wall chart or blackboard so that schedules can be easily referred to. 2. Estimate anticipated manpower needs for all upcoming jobs, including vacation, holidays, normal absences, etc. 3. Be sure each long-range job is clearly identified. Leave a time gap in scheduling to take care of emergencies or other unexpected situations. 4. Determine training requirements and their effect on the schedule. 5. Review reasons for delays on previous jobs, and plan how to avoid them. 6. Visit the jobsite ahead of time. 7. Obtain store withdrawal authorizations. 8. Locate any special materials, tools, or equipment needed for the job. 	<ol style="list-style-type: none"> 1. Review priorities of scheduled activities. 2. Check for patterns and trends in previous emergencies. 3. Evaluate work routines. Are maintenance personnel showing up late or without correct tools? 4. Remind maintenance personnel to incorporate all safety procedures, making sure they understand the importance of complying with OSHA requirements. 5. Order parts and materials needed from outside sources as early as possible. 6. Conduct scheduling meetings to review job status priorities. 7. Verify that maintenance objectives are being achieved on scheduling. 8. Determine the reasons for any breakdowns in scheduling. 9. Can more efficient scheduling help reduce maintenance manpower?

Table 1-2. A long-range schedule

Work description and location	Priority	Week opened	Task time		Crafts involved	Production informed	Week completed	Costs	
			Actual	Estimated				Actual	Estimated

Table 1-3. A short-range schedule

Work description	Location	Date/time started	Estimated time	Date/time completed

16 Programmed Exercises

1-9. During the decision step in your maintenance plan, you should assign _____ to your maintenance projects.	1-9. PRIORITIES Ref: 1.31
1-10. The more time you spend supervising, the greater your crew's _____.	1-10. PRODUCTIVITY Ref: 1.32
1-11. A document authorizing work to proceed is called a maintenance _____.	1-11. JOB ORDER Ref: 1.34
1-12. Emergency work that must be handled immediately is Priority _____ work.	1-12. ONE Ref: 1.43
1-13. Maintenance isn't likely to achieve much without production's _____.	1-13. COOPERATION Ref: 1.45
1-14. Pinpointing a time in the future when a major maintenance task will be started is called _____ scheduling.	1-14. LONG-RANGE Ref: 1.47
1-15. In short-range scheduling, you consider the workload for the next one or two _____.	1-15. WEEKS Ref: 1.48
1-16. You will be able to allocate manpower efficiently by using _____.	1-16. SCHEDULES Ref: 1.49

Answer the following questions by marking an "X" in the box next to the best answer.

- 1-1. Which of the following is *not* a PM function?
- a. Lubricating
 - b. Rebuilding
 - c. Replacing components
 - d. Testing
- 1-2. With which kind of equipment is PM effective?
- a. Equipment in any condition
 - b. Equipment in need of an overhaul
 - c. Equipment that is up to standard
 - d. All of the above
- 1-3. Emergency labor is usually more expensive than regular labor by
- a. 15%
 - b. 25%
 - c. 50%
 - d. 100%
- 1-4. If you cannot inspect every piece of equipment, PM can still be effective by concentrating on equipment whose failure can
- a. affect product quality
 - b. cause large losses by functioning improperly
 - c. endanger the health of personnel
 - d. all of the above
- 1-5. When conducting inspections,
- a. concentrate on key areas
 - b. examine every piece of equipment in the facility
 - c. randomly sample equipment on and off the route
 - d. take time to correct all faults
- 1-6. Which of the following offer the greatest opportunity for both immediate and long-term improvements?
- a. Establishing maintenance routes
 - b. Planning
 - c. Scheduling
 - d. Setting priorities
- 1-7. Priorities for maintenance jobs should be assigned during which stage of the planning process?
- a. Decision
 - b. Implementation
 - c. Review
 - d. Routing
- 1-8. Which of the following is *not* true of the maintenance job order?
- a. It authorizes work to proceed
 - b. It is a tool for allocating job costs
 - c. it is prepared by whoever needs the work done
 - d. It is used to issue stock
- 1-9. Scheduled maintenance that must be completed within two weeks to avoid safety hazards, downtime, or equipment damage is considered
- a. priority one
 - b. priority two
 - c. priority three
 - d. priority four
- 1-10. Deferred maintenance that should be completed only as labor becomes available is considered
- a. priority two
 - b. priority three
 - c. priority four
 - d. priority five

SUMMARY

While maintenance is not likely to be considered a glamour activity, everyone is usually painfully aware when it fails. Such failures can result in danger to health and safety, exasperating delays, excessive downtime, and expensive emergencies—situations not likely to be ignored for long.

The key to effective maintenance is control before, rather than after, the fact. This means that maintenance must develop a close relationship with production, based on the contribution maintenance makes to help production achieve its

objectives. Maintenance must understand production's goals before it can improve its performance.

Certainly, maintenance must have the determination to maintain equipment at standards that will help to eliminate dangers and downtime. Finally, the skills and capabilities of maintenance personnel must be stimulated through effective training and supervision. The result can only be better qualified personnel.

Answers to Self-Check Quiz

- | | | | | | |
|------|----|--|-------|----|--|
| 1-1. | b. | Rebuilding. Ref: 1.03 | 1-6. | b. | Planning. Ref: 1.20 |
| 1-2. | c. | Equipment that is up to standard.
Ref: 1.03 | 1-7. | a. | Decision. Ref: 1.31 |
| 1-3. | a. | 15%. Ref: 1.04 | 1-8. | d. | It is used to issue stock.
Ref: 1.34–1.36 |
| 1-4. | d. | All of the above. Ref: 1.09 | 1-9. | b. | Priority two. Ref: 1.43 |
| 1-5. | a. | Concentrate on key areas.
Ref: 1.17 | 1-10. | d. | Priority five. Ref: 1.43 |

Contributions from the following sources are appreciated:

- Figure 1-2. Alcoa
Figure 1-3. Volvo CE