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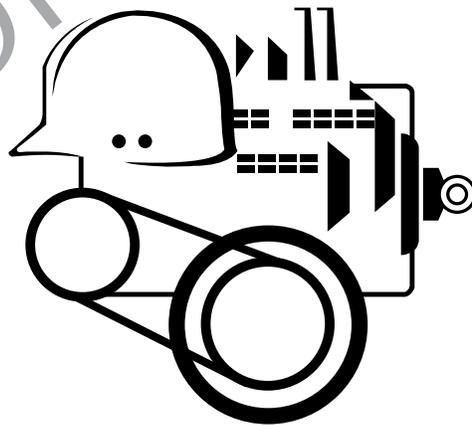
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***IMPROVING PERFORMANCE IN MAINTENANCE***

***Lesson One***

***Evaluating  
Performance***



***TPC Training Systems***

90401

**Lesson****1****Evaluating Performance****TOPICS**

Determining Areas of Responsibility  
 Measures of Performance  
 Utilizing Labor  
 Measuring Material Use  
 Control Practices  
 Supervisory Practices  
 Hourly Activity Patterns

Controlling Costs  
 Controlling Personnel  
 Reading Performance Trends  
 Reports to Keep Weekly  
 Reports to Keep Monthly  
 Measuring Performance

**OBJECTIVES**

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

- Give examples of the different interest levels of key maintenance personnel.
- Compute annual productive hours per worker.
- Compute cost per productive hour.
- List indicators that can help a supervisor control costs.
- Tell how performance trends are established.

**KEY TECHNICAL TERMS**

**Annual productive hours per worker** 1.11 an index figure used as a measure of labor utilization  
**Cost per productive hour** 1.11, 1.13 total cost of one hour of work, used as a labor index  
**Hourly activity patterns** 1.20 work habits, such as late starts, that indicate whether crew members are using their time effectively

**Trend line** 1.25 degree of improvement shown by repeated measurements of performance indicators

To improve maintenance performance, you must establish a number of measurements or “benchmarks” upon which the performance of your department can be documented. Then, armed with the knowledge of how the department is actually performing, you must make good elements better and discard the bad. This calls for measurements to determine the effectiveness of the various parts that make up maintenance performance.

There are many indicators of maintenance performance—labor use, materials, costs, backlog reduction, etc. Each indicator measures a specific area of performance, but a single indicator rarely gives a total performance picture. A combination of such data is required for an overview of performance.

Once you know the level of performance, the next move is to identify the causes of poor performance and take corrective action. The purpose of this lesson is to familiarize you with these corrective actions and their use so that you can improve maintenance performance.

### Determining Areas of Responsibility

1.01 In supervising maintenance, you must be able to see how your needs for performance information fit within the total organization (Fig. 1-1 on the following page). As the *maintenance supervisor*, you are most interested in what must be done during each shift. You are probably less concerned about next week. *Maintenance superintendents* need information that will produce a successful week. Although they normally work a five-day week, they may be called in at other times for major problems. Thus, they must also know the capability of first-line supervisors. *Maintenance managers* must look further ahead and divide their attention between a successful overall maintenance program and work projects assigned specific completion dates. They are responsible for everything done by the maintenance department. They take credit for its successes and are accountable for its failures.

1.02 The following questions show different interest levels of key maintenance personnel.

#### Materials

- Maintenance manager—Is material control effective?
- Maintenance superintendent—Are critical parts available?
- Maintenance supervisor—Can parts be obtained quickly?

#### Overtime

- Manager—Is premium labor still under budget?
- Superintendent—Is overtime used well?
- Supervisor—Who is assigned overtime?

#### Union

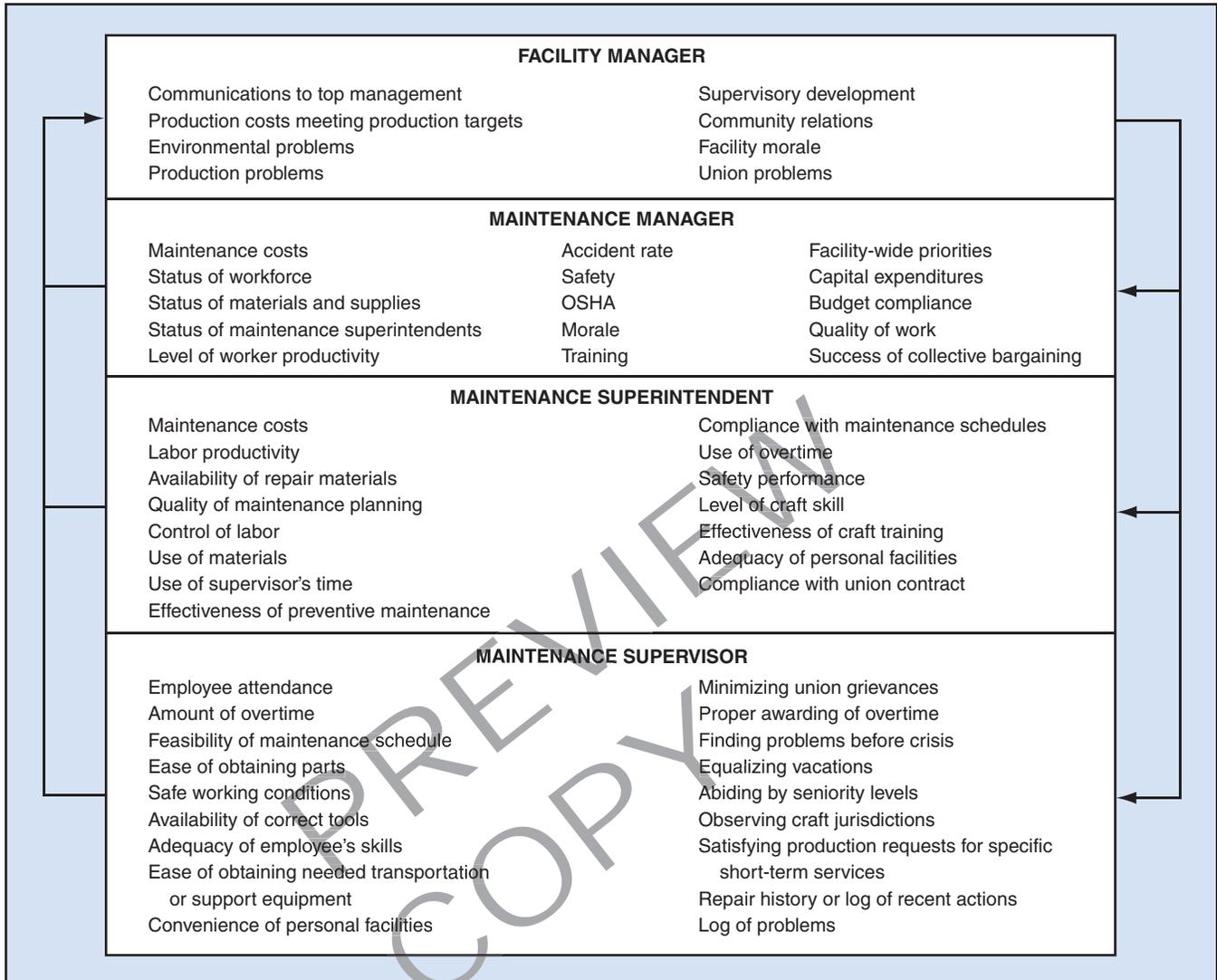
- Manager—Is the current approach to collective bargaining successful?
- Superintendent—Is the facility in compliance with the union contract?
- Supervisor—What are the best ways to use the various crafts in order to avoid grievances?

1.03 The maintenance manager needs summary and trend information that shows whether maintenance is going in the right direction. Consequently, the need for reports and summaries is greatest.

1.04 Because there is so much information to choose from, the maintenance manager must carefully select information that gives a valid picture of performance.

1.05 The maintenance superintendent needs specific details of labor use, overtime, absenteeism, status of major repairs, and costs. Trend and summary information is helpful, but it is not the prime need.

**Fig. 1-1. Areas of responsibility**



1.06 The maintenance supervisor wants the very latest information. If anything happened during the preceding shift that may cause problems, the supervisor wants to know. Of less interest are trends, reports, and summaries.

**Measures of Performance**

1.07 The areas that are critical to performance at the first-line supervisory level are shown in Fig. 1-2. They include:

- labor utilization
- materials use
- control practices

- supervisory practices
- hourly activity patterns
- costs
- personnel.

1.08 To measure progress, you must first collect performance information on each area that is important to the control of your operation.

1.09 If you have been using a work breakdown analysis or job task analysis, this will make it easier for you to gauge performances. The data collected through these analyses allow for you to identify

places for improved productivity, routine, and efficiency.

### Utilizing Labor

1.10 Worker productivity is the primary measure of labor utilization. Work-sampling techniques give an index of productivity. In work sampling, an observer follows an established route and records the activity of each worker. The number of workers performing productive work can be converted to a percentage of productivity.

1.11 Two good measures of labor utilization are *annual productive hours per worker* and *cost per productive hour*. By computing and then graphing both of these factors, you can discover trends in labor use.

1.12 To measure labor utilization, begin with annual productive hours per worker using the following equation:

$$H = \frac{(R + O)P}{N}$$

where H = productive hours

R = regular hours

O = overtime hours

P = productivity (%)

N = number of workers.

**Fig. 1-2. Areas critical to supervisory performance**

MAINTENANCE PERFORMANCE INDICATORS	
<p>1. Labor Utilization</p> <p>a. Worker productivity (time spent at the worksite, using tools, and performing production work) measured by work sampling</p> <p>b. Annual productive hours per worker, compute from:</p> $H = \frac{(R + O) \times P}{N}$ <p>where: H = productive hours R = regular hours O = overtime hours P = productivity N = number of workers</p> <p>c. Cost per productive hour, found from</p> $C = \frac{W + M + F + D}{H}$ <p>where: C = cost per productive hour W = wage cost M = overtime premium F = fringe benefits D = overhead H = number of productive hours</p> <p>2. Materials Use</p> <p>a. Average number of warehouse withdrawals per month</p> <p>b. Annual holding cost of inventory</p> <p>c. Average value of withdrawals per month</p> <p>d. Inventory turnover rate</p> <p>e. Ratio of cost of materials drawn from warehouse to total material cost</p> <p>f. Cost of materials used per worker per year</p> <p>g. Ratio of labor cost to material cost</p>	<p>3. Control Practices</p> <p>a. Percentage of manhours for unscheduled work</p> <p>b. Percentage of manhours for emergency work</p> <p>c. Percentage of manhours for scheduled work</p> <p>d. Backlog level</p> <p>e. Number of work orders in the backlog</p> <p>f. Average number of work orders initiated each week</p> <p>4. Supervisory Practices</p> <p>a. Percentage of supervisor's time spent on direct supervision</p> <p>b. Percentage of supervisor's time spent in work areas</p> <p>5. Hourly Activity Patterns</p> <p>a. Percentage of time lost due to late starts or early quits</p> <p>b. Percentage of time lost as a result of idle time or no work assignments</p> <p>b. Percentage of time used as personal time</p> <p>6. Costs</p> <p>a. Ratio of maintenance costs to total production costs</p> <p>b. Units of product per maintenance dollar</p> <p>c. Premium labor cost as percentage of total maintenance labor cost</p> <p>d. Maintenance labor cost as percentage of total production labor cost</p> <p>e. Total maintenance cost</p> <p>7. Personnel</p> <p>a. Total number of hourly maintenance personnel</p> <p>b. Number of hourly personnel per maintenance supervisor</p>

To illustrate this computation, assume that ten workers at 45% productivity work 20,000 regular hours and 1450 overtime hours.

$$H = \frac{(20,000 + 1450) \times 0.45}{10}$$

= 965 annual productive hours per worker

When productivity increases, the number of productive manhours per worker per year increases.

1.13 The cost per productive hour is the cost of doing one hour of work. This index is computed as follows:

$$C = \frac{W + M + F + D}{H}$$

where C = cost per productive hour

W = annual regular wage cost

M = annual overtime premium

F = annual fringe benefit

D = annual overhead

H = annual productive hours per worker.

As an illustration, assume that ten workers are each paid \$20 per hour for regular hours (\$400,000). They work 1450 overtime hours at time-and-a-half (\$43,500). They are paid \$3000 each in annual fringe benefits (\$30,000). Overhead is 10% of the annual regular wage (\$40,000).

$$C = \frac{\$400,000 + \$43,500 + \$30,000 + \$40,000}{965 \times 10}$$

= \$53.21

Compute this index initially to establish a point of reference and then periodically to help determine progress. The cost per hour figure should decrease as labor utilization becomes more efficient.

**Measuring Material Use**

1.14 The use of materials can measure the effectiveness of material installation. One way to measure is to

add up the cost of materials a worker uses in a year. This index, plotted over a period of time, reveals the changes in materials consumed per maintenance employee. An increase may show an increased effectiveness.

1.15 To come up with a performance index, study the labor cost of installing each dollar's worth of material. You can do this by dividing total labor cost by total material cost. In later measurements, a figure lower than the initial one indicates improvement.

1.16 In facilities where maintenance has a close working relationship with the warehouse or controls the warehouse, there are other indicators to consider:

- average number of warehouse withdrawals per month
- annual holding cost of inventory
- average value of withdrawals per month
- inventory turnover rate
- ratio of stock versus purchased material (giving an idea of how well stocked items anticipate repair requirements).

**Control Practices**

1.17 The number of work orders, the amount of backlog, and the use of manhours indicate the effectiveness of control practices. Some control patterns and targets are:

- lowering unscheduled work to no more than 12–15% of total manhours
- lowering emergency work to no more than 8–10% of total manhours
- increasing scheduled work to 50–60% of total manhours
- stabilizing or decreasing the backlog level—no more than three to six weeks' backlog per craft
- decreasing the number of work orders within the backlog, showing an improved completion rate
- increasing the average number of work orders initiated each week, then leveling off, show-

**Fig. 1-3. Keeping a daily log promotes better use of time**

Time	Activity	Duration (min)	Percent of workday
7:00	Meeting, Paperwork	23	4%
7:35	In facility...supervising	150	30%
10:05	Phone	12	2%
10:20	Break	10	2%
10:30	In facility...		
	..supervising	45	9%
11:15	Lunch		
Summary	Meetings - Paperwork		12%
	Phone		7%
	Supervising		62%
	Coordination		8%

ing a consistent performance of preventive maintenance inspections.

### Supervisory Practices

1.18 Actual supervising of personnel is the most important part of a supervisor's job. The time spent on active, personal supervision relates directly to a crew's productivity. The more time a supervisor spends supervising, the greater the chance that productivity will be better. A suitable target for a supervisor is to spend 60% or more time supervising the workforce.

1.19 As a supervisor, you should find out what you actually do with your time. Filling in a log sheet (Fig. 1-3) is helpful. On the daily log, note each activity, its starting time, its duration, and the percent of the workday it represents. (On eight-hour shifts, each five minutes is about 1% of the workday.)

### Hourly Activity Patterns

1.20 Are crew members using their time effectively, or is time being wasted? Ask yourself these questions:

- How much time is lost getting organized at the beginning of the shift?
- How much time is lost because coffee breaks and lunch periods are longer than authorized?
- How much time is lost because crews are leaving the worksite early?
- How much scheduled working time is lost because it is used as personal time?

Use these points to decide on corrective actions to be taken.

**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. The maintenance manager needs summary and _____ information.</p>	<p>1-1. TREND Ref: 1.03</p>
<p>1-2. The very latest information is most important to the maintenance _____.</p>	<p>1-2. SUPERVISOR Ref: 1.06</p>
<p>1-3. Worker productivity is the primary measure of labor _____.</p>	<p>1-3. UTILIZATION Ref: 1.10</p>
<p>1-4. In work sampling, an observer follows an established _____ and records the activity of each worker.</p>	<p>1-4. ROUTE Ref: 1.10</p>
<p>1-5. When productivity increases, the number of _____ manhours per worker per year increases.</p>	<p>1-5. PRODUCTIVE Ref: 1.12</p>
<p>1-6. The use of materials can measure the _____ of material installation.</p>	<p>1-6. EFFECTIVENESS Ref: 1.14</p>
<p>1-7. Unscheduled work should be reduced to no more than _____ of total manhours.</p>	<p>1-7. 12–15% Ref: 1.17</p>
<p>1-8. To find out how they spend their time, supervisors should fill out a daily _____.</p>	<p>1-8. LOG SHEET Ref: 1.19</p>

## Controlling Costs

1.21 Certain cost-related indicators can help you judge cost performance. You should check these to make sure you are doing your part in the cost-control effort.

In one facility, the maintenance supervisors' job was to get equipment repaired and nothing more. They had no further responsibility for control of costs. Because the maintenance department lacked any contribution from the level of supervision closest to the work, costs were high and control was poor. In short, the very supervisors most needed in the cost control effort were outside it. Realizing the result of this, the organization gave supervisors added responsibilities, starting with budget preparation and control of expenditures. Supervisors became more aware of the cost of supplies and materials and made several changes in repair methods. The result was a significant cost improvement based on help from the supervisory level.

Supervisors need not collect this information but they must know what is meaningful. Accounting or clerical personnel can easily prepare the actual data.

1.22 Specific, helpful indicators that can assist the supervisor in cost control include:

- The ratio of maintenance costs (labor plus material) should decrease in relation to production costs.
- Product units should increase in relation to maintenance dollars spent.

- Premium labor costs (overtime) should become a lower percentage of total maintenance labor costs.
- Maintenance labor costs should become a lower percentage of total production labor costs.
- Total maintenance costs should become lower.

## Controlling Personnel

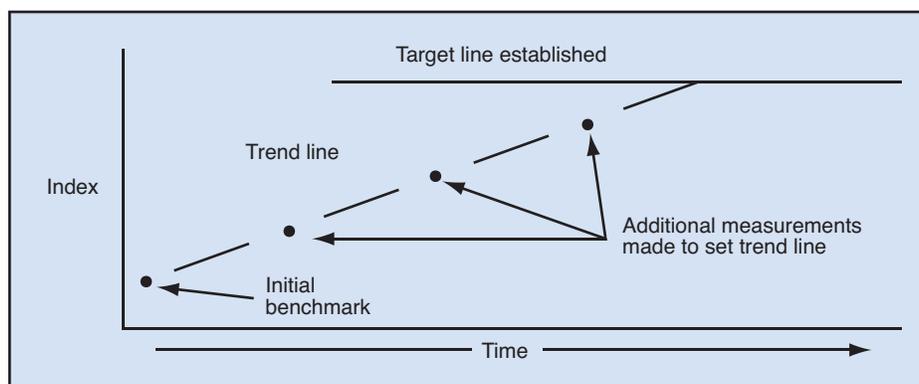
1.23 Each supervisor within the maintenance organization has a span of control. Generally, the greater the span of control, the less effective the control is. For instance, a supervisor with 30 workers has a thinned-out span of control (1:30) compared to a supervisor with eight workers to direct (1:8).

1.24 Similarly, the size of the maintenance workforce is an indicator of control. A reduction in the total number of maintenance personnel without a change in the workload shows an improvement in the control of personnel.

## Reading Performance Trends

1.25 To use performance indicators effectively, you must use them to establish performance trends. Once indicators are selected, take an initial benchmark measurement. Later measurements establish a trend line. This *trend line* shows the degree of improvement (or lack of it) in relation to the targeted improvement (Fig. 1-4).

**Fig. 1-4. Read performance by measuring trends against a static target**



**Fig. 1-5. Measuring maintenance performance**

Measurement Factors	Year 1	Year 2	Year 3
Worker productivity, percent	32%	37%	43%
Productive hours per worker per year	576	666	774
Cost per productive hour	\$16.12	\$11.42	\$9.21
Percent of materials drawn from warehouse	31%	50%	63%
Percent of supervisor's time spent on supervision	37%	47%	62%
Units of product per maintenance dollar	1.51	1.70	1.89
Number of hourly employees	123	110	102
<b>Total Maintenance Cost</b>	<b>\$3,750,000</b>	<b>\$3,921,050</b>	<b>\$4,017,521</b>

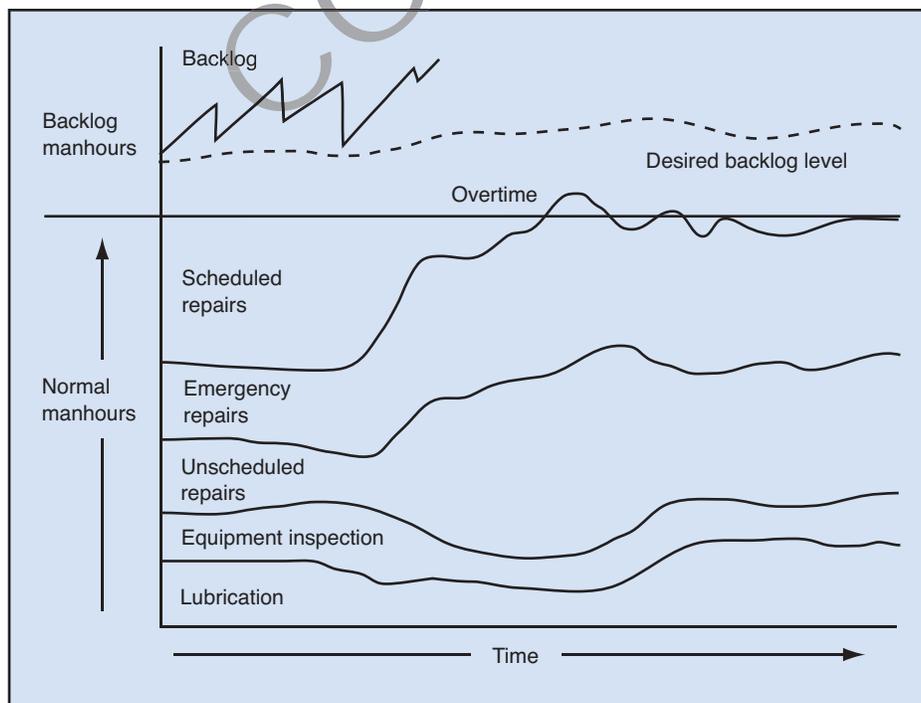
1.26 Various indicators—worker productivity, productive hours and their cost, etc.—taken together can establish a clear picture of performance. Follow these indicators over a period of time, as shown in Fig. 1-5.

1.27 In addition to long-term evaluation of performance factors, running reports is necessary for establishing short-term control. They become the basis for decisions that ensure long-term improvements. The maintenance supervisor keeps the running reports, some weekly, some monthly.

**Reports to Keep Weekly**

1.28 List the manhours for each craft within specific departments spent on preventive maintenance inspections, lubrication, unscheduled work, emergency work, scheduled work, repetitive jobs, and operations support. The percentage distribution of these manhours reflects labor use. A high percentage of scheduled work shows good use of labor. A high percentage of unscheduled or emergency work shows a need for better planning and preventive maintenance. See Fig. 1-6.

**Fig. 1-6. Manhour utilization trends**



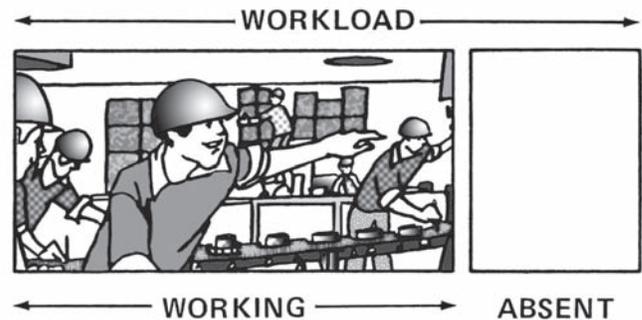
1.29 Overtime, by craft, within specific departments pinpoints where to reduce emergency and unscheduled work. It can also reveal whether the size of the workforce is sufficient for the workload.

1.30 Absenteeism totals show whether enough workers are available to meet the workload (Fig. 1-7). Unexcused absences adversely affect your ability to control the maintenance schedule. A successful supervisor keeps good records of absences and tardiness and takes positive actions to control them.

1.31 Keep a record of the status of major jobs—from start to finish. Compare the manhours used with standards or estimates to determine job performance. Keeping sight of the projected time of job completion is important in any case. It is particularly important when other work hinges on the completion. Major job costs are important factors in overall cost control.

1.32 Backlog status reveals job turnover trends and indicates whether the backlog is decreasing or holding at a manageable level. Unless the manhours spent for scheduled work approach 50% of the total available, the backlog will increase. Jobs in the backlog will slip to unscheduled and, eventually, to emergency status (Fig. 1-8).

**Fig. 1-7. Absenteeism must be minimized**

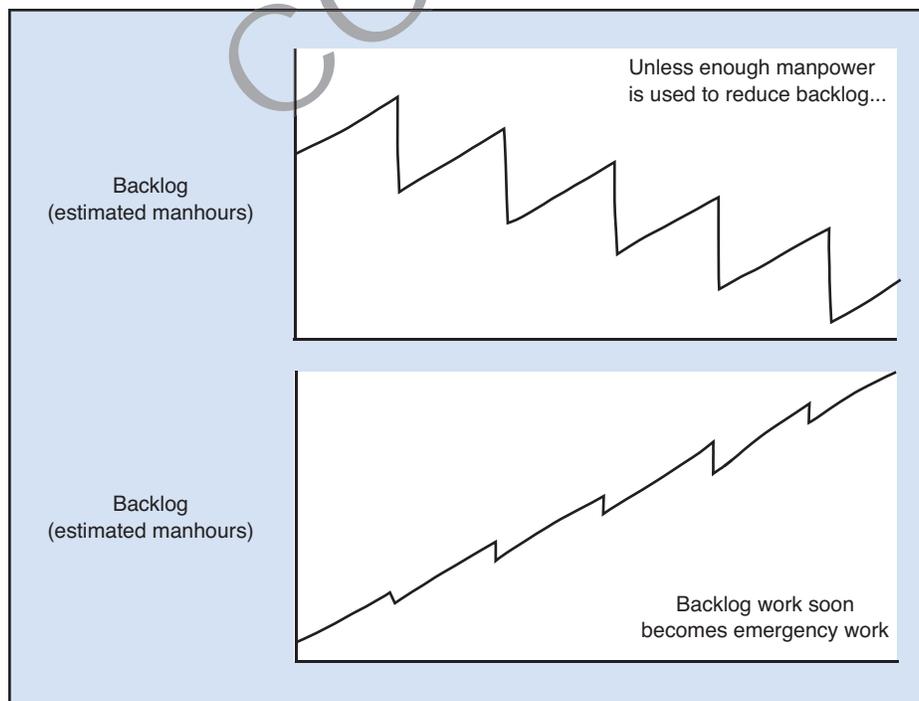


### Reports to Keep Monthly

1.33 Maintenance cost reports should show the cost of labor and materials charged against key units of equipment, major jobs such as lubrication and equipment inspection, and particular standing work orders. Each monthly report should include a year-to-date summary. Often, the number of manhours spent for regular and overtime work, shown with the labor cost, is helpful in judging the scope of work.

1.34 Combining data from these reports with certain production statistics gives a helpful measurement of maintenance elements. For example, comparing

**Fig. 1-8. How backlog affects emergency work**



**Fig. 1-9. The supervisor must interpret the indicators**



monthly maintenance costs with total units of production will show maintenance cost per unit. This ratio can provide a reliable indication of maintenance efficiency, but it must be established on the basis of proved historical data (unique to your facility).

**Fig. 1-10. Identify critical areas to help you choose the indicators you need**

#### Steps in setting indicators of performance

- I. Identify at least three influential areas:
  - labor use
  - cost
  - downtime
- II. Arrange indicators to bring together several aspects of each area:
  - manhours per unit
  - cost per unit
  - downtime vs. operating hours
- III. Make initial measurements, set targets, and use subsequent measurements to determine progress.

1.35 The maintenance manager's primary interest is in trends and summaries that provide a long-term view of progress. However, as maintenance supervisor, you must collect and use details of labor use, job progress, and costs. You must monitor the summaries of these data. You must build a comprehensive and reliable information program, carefully choosing those indicators that provide the best measure of performance.

#### Measuring Performance

1.36 After working with the most meaningful indicators and measuring them to establish trends and objectives, you will discover that some of them are more reliable than others. Discontinue using the less-reliable indicators. The point is to determine which statistics reliably describe your performance. No single index is adequate. Several are necessary to reinforce the decisions you make about how your activity is progressing.

1.37 The real objective of measuring performance is to help identify the areas that need improvement. The performance indicators you choose will not prescribe the exact changes needed, but they will point out where improvement is needed.

1.38 Analyze the situation in these trouble spots, identify the required improvements and carry them out. Then check related indicators to note the effectiveness of your actions.

A measurement of hourly activity patterns showed that late starts in one facility were costing more than 25 minutes per day for each worker of a 45-member maintenance crew. Investigation revealed that workers had to change into work clothes in a remote area of the facility, walking there and back consumed considerable time. A different changing room nearer the job was assigned. Later measurements of late starts (the index) showed a reduction to less than 12 minutes per day.

1.39 As maintenance supervisor, you must be able to interpret the statistics you use to monitor performance. Some are clear, as in the example of the changing room. Some are not clear and merely indicate problems (Fig. 1-9).

A facility in an agricultural community adjusted to high absenteeism at planting and harvest times. Then, one year absenteeism was high at times other than planting and harvest. The supervisor, looking at the overtime index, realized that workers simply took time off to rest up. They were exhausted by excessive overtime.

In another case, maintenance crews on regular shifts performed a substantial amount of construction work (part of a facility expansion). Virtually the entire maintenance program was being done as overtime and some of it on weekends at double time. A contractor came in to do the construction, and the overtime, as well as absenteeism, quickly returned to normal.

Answers are not always obvious. One index cannot provide all necessary clues. Figure 1-10 shows the steps involved in choosing performance indicators. Experiment. Then watch the indicators to see if you acted correctly.

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## 16 Programmed Exercises

<p>1-9. The ratio of maintenance costs should _____ in relation to production costs.</p>	<p>1-9. DECREASE Ref: 1.22</p>
<p>1-10. Generally, the greater the span of control the _____ effective the control.</p>	<p>1-10. LESS Ref: 1.23</p>
<p>1-11. Reducing the number of crew members without changing the workload shows an _____ in the control of personnel.</p>	<p>1-11. IMPROVEMENT Ref: 1.24</p>
<p>1-12. To use performance indicators effectively, you must establish performance _____</p>	<p>1-12. TRENDS Ref: 1.25</p>
<p>1-13. Good use of labor is reflected by a high percentage of _____ work.</p>	<p>1-13. SCHEDULED Ref: 1.28</p>
<p>1-14. Overtime can reveal whether the size of the workforce is sufficient for the workload. True or False?</p>	<p>1-14. TRUE Ref: 1.29</p>
<p>1-15. In order to determine job performance, compare the manhours used with _____ or estimates.</p>	<p>1-15. STANDARDS Ref: 1.31</p>
<p>1-16. Each monthly report should include a _____ summary.</p>	<p>1-16. YEAR-TO-DATE Ref: 1.33</p>

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

- 1-1. Obtaining parts quickly is most likely to be the concern of the
- a. crew member
  - b. maintenance manager
  - c. maintenance superintendent
  - d. maintenance supervisor
- 1-2. Which of the following data are critical to performance at the first-line supervisory level?
- a. Costs
  - b. Labor utilization
  - c. Material use
  - d. All of the above
- 1-3. Cost per production hour
- a. cannot be used to discover trends
  - b. increases with the efficiency of labor utilization
  - c. is the daily cost of doing work
  - d. measures labor utilization
- 1-4. How much time should a supervisor try to devote to supervising the workforce?
- a. 30%
  - b. About 50%
  - c. 60% or more
  - d. 85% or more
- 1-5. The supervisor in charge of a 20-worker crew generally has more control than
- a. a supervisor in charge of 8 workers
  - b. a supervisor in charge of 30 workers
  - c. a supervisor who controls a mixed craft crew
  - d. a supervisor who must supervise engineering support work
- 1-6. The trend line shows
- a. the degree of improvement
  - b. the ratio of maintenance costs
  - c. the size of the maintenance workforce
  - d. the supervisor's span of control
- 1-7. The distribution of manhours among the work categories reflects
- a. a need for PM
  - b. labor costs
  - c. labor performance
  - d. labor use
- 1-8. Maintenance cost reports should show
- a. major jobs such as lubrication
  - b. particular standing work orders
  - c. the cost of labor and materials
  - d. all of the above
- 1-9. Comparing monthly maintenance costs with total units of production reveals
- a. maintenance cost per unit
  - b. maintenance labor costs
  - c. material usage
  - d. production costs
- 1-10. The real objective of measuring performance is to
- a. determine maintenance costs
  - b. determine work distribution
  - c. identify areas that need improvement
  - d. update historical data

## SUMMARY

No busy supervisor can supervise adequately and study detailed reports at the same time. Yet, as a supervisor, you are also fully responsible for the success of your area of operation. Therefore, you must boil down the volume of performance data available into meaningful indicators that will tell you instantly how you are doing.

Identifying critical areas of your operation will help you identify the information you need.

Watching the most reliable indicators—and the trends they reveal—will make it possible for you to evaluate your operation.

You will be able to identify problem areas and take corrective actions. Finally, you can tell if these corrective actions are effective by continuing to observe your indicators closely.

## Answers to Self-Check Quiz

- |      |   |       |   |
|------|---|-------|---|
| 1-1. | d. Maintenance supervisor.<br>Ref: 1.02               | 1-6.  | a. The degree of improvement.<br>Ref: 1.25            |
| 1-2. | d. All of the above. Ref: 1.07                        | 1-7.  | d. Labor use. Ref: 1.28                               |
| 1-3. | d. Measures labor utilization.<br>Ref: 1.11           | 1-8.  | d. All of the above. Ref: 1.33                        |
| 1-4. | c. 60% or more. Ref: 1.18                             | 1-9.  | a. Maintenance cost per unit.<br>Ref: 1.34            |
| 1-5. | b. A supervisor in charge of 30 workers.<br>Ref: 1.23 | 1-10. | c. Identify areas that need<br>improvement. Ref: 1.37 |