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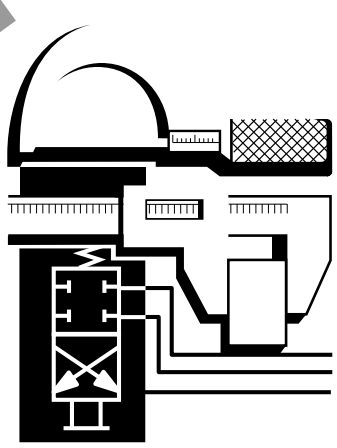
TROUBLESHOOTING SKILLS

Lesson One

Introduction to Troubleshooting



TPC Training Systems

11001

Lesson

1 Introduction to Troubleshooting

TOPICS

Troubleshooting
Troubleshooting Skills
Troubleshooting Duties
Troubleshooting Aids
Mechanical Troubleshooting
Electrical Troubleshooting
Importance of Maintenance
Maintenance Organization
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Challenge of Maintenance

OBJECTIVES

After studying this lesson, you should be able to…

- Tell why efficient troubleshooting is important in a production plant.
- Name the four common troubleshooting aids.
- List the steps in troubleshooting a machine.
- List the steps in troubleshooting a system.
- Describe a typical maintenance organization.

KEY TECHNICAL TERMS

Troubleshooting 1.01 diagnosing machine malfunction
Schematic 1.15 line diagram
Multimeter 1.18 combination electrical measuring instrument
Ammeter 1.18 current-measuring instrument
Megohmmeter 1.18 resistance-measuring instrument
Millwright 1.50 maintenance worker with many mechanical skills

If you like to "go looking for trouble" you will enjoy being a troubleshooter. Everyone is a troubleshooter in a way. When something does not work properly—the car, the washing machine, or the lamp—you try to find the cause of the trouble and eliminate it. At home, you may be called a do-it-yourselfer, a handyman, or a Mr. Fix It. In the plant you will be called a troubleshooter.

This lesson explains troubleshooting—what it is and how it applies to the maintenance department in your plant. It describes various kinds of troubleshooting and troubleshooting aids and equipment that make your job easier. This lesson emphasizes the role of the maintenance specialist and the importance of being organized. And it emphasizes the idea that everyone must work together to produce better results.

Troubleshooting

1.01 Before you can repair a machine or other equipment, you must find the cause of the problem. *Troubleshooting* is the process of finding the cause of a machine or equipment failure and correcting it.

1.02 The hit-or-miss approach to problem solving is for the unskilled worker. The skilled troubleshooter or maintenance specialist follows a plan to locate a problem. By studying equipment to determine the most likely causes of failure, as shown in Fig. 1-1, the troubleshooter can zero in on the actual cause.

1.03 Once the cause of the failure has been determined, the maintenance specialist can correct the trouble, as shown in Fig. 1-2 on the following page. In addition to repairing or replacing a broken or damaged component, you must also eliminate the cause of the failure. If you do not, the equipment may fail again, and create other problems as well.

Troubleshooting Skills

1.04 To be a good troubleshooter, you must understand the normal operation of machines and systems. You must also be good at making repairs and know what tools to use and how to use them properly. You acquire these skills through education, training, and experience.

1.05 An experienced troubleshooter often can recognize the cause of a problem immediately when called to check a machine. When you have worked on a similar machine before, you know the types of repairs most often required. So you will first check the parts most likely to be involved in the breakdown. One by one, you can eliminate the most likely causes of a particular failure. You can locate the problem within a few minutes, thus keeping downtime to a minimum.

1.06 Not all machine failures are due to incorrect use or maintenance. Some are caused by built-in defects in the machine. These defects originate while the machine is being designed and built. Through

Fig. 1-1. A troubleshooter looks for problems

Fig. 1-2. A troubleshooter corrects a problem

experience, you will often be able to spot the difference. In some cases, you will make the repair to save time, even though the manufacturer is responsible.

1.07 Sometimes you should not correct the manufacturer's error. In other words, you must know when to leave the problem uncorrected. A warranty may be voided if an unauthorized person works on the machine. Your supervisor should decide who will make repairs on the machine.

1.08 For example, suppose you check a machine and decide that the trouble is in a sealed housing. Before calling the manufacturer, you check the installation and maintenance manuals provided with the machine to see if you can make the repair and save time. However, no disassembly instructions are included in the manuals.

1.09 Your next step may be to call the manufacturer or an authorized representative to make the repair. Or you may replace the entire housing and return the old one to the manufacturer for service. Sometimes a worn or broken part may cause a machine to fail. New parts can take several weeks to arrive. To prevent lengthy downtime, you may be able to find or make a substitute part to keep the machine running until the new part arrives.

Troubleshooting Duties

1.10 An efficient troubleshooter can prevent most downtime and restore a machine to service quickly if a breakdown occurs. Reducing downtime is important. When a production machine breaks down, costs continue while workers stand idle and goods are not being produced. Delivery dates may not be met, and customers' orders may be canceled because goods cannot be made and shipped on time. Canceled orders cost jobs.

1.11 In addition to finding and correcting the cause of a breakdown, a skilled troubleshooter also diagnoses minor problems while the machine is still running. For example, if a machine is producing too many rejects, the troubleshooter can trace the problem. Then he or she can make the necessary repairs or call a technician to do it.

1.12 In a small plant, the troubleshooter is usually a jack-of-all-trades. He works on all plant equipment and systems. In a large plant, the troubleshooter may perform only certain kinds of repairs. For example, he may be a mechanical or electrical specialist. Or, he may troubleshoot and make repairs only in building structures and systems.

Troubleshooting Aids

1.13 As a troubleshooter, you can find the cause of a problem more quickly and efficiently by developing good troubleshooting techniques. You will also use various troubleshooting aids, including instruction manuals, checklists, schematics, diagrams, test equipment, and other diagnostic tools. Production workers are also valuable sources of information about the machines and equipment they work on.

1.14 Machine history records, technical books and magazines, troubleshooting charts, and manufacturer's service manuals are useful troubleshooting aids. Drawings are also helpful. Parts lists illustrate the parts of a machine. Assembly drawings and blueprints show the physical location of machine or system components.

1.15 *Schematics* are simple line diagrams that show how a system works. They show the relationship between the system components. Schematics use *symbols* instead of pictures. The symbols are connected to form a complete system in a simplified drawing.

1.16 *Elementary diagrams* are special control schematics. They simplify the study and understanding of the control systems. Elementary diagrams may be of electrical, hydraulic, steam, or air systems, or a combination of several such systems.

1.17 You will use electrical and mechanical test equipment to troubleshoot electric circuits and mechanical systems. Basic electrical troubleshooting equipment includes a multimeter, a clamp-on ammeter, a megohmmeter, and a pocket voltage tester.

1.18 The *multimeter* measures resistance (in ohms), potential difference (in volts), and current (in amperes). An *ammeter* measures the current in a conductor. Insulation resistance is measured with a *megohmmeter*.

1.19 *Thermometers* and *thermocouples* for measuring temperature are examples of mechanical test equipment. Other examples include *thickness gauges* for checking alignment and clearances between machine components, and *flowmeters* for measuring fluid flow.

1.20 Testing devices are some of the troubleshooter's best diagnostic tools. Therefore, you must become skilled in using them. Study the instruction manual and try out each device before you need to use it.

1.21 Always ask the machine operator for information on the problem. The operator usually understands the operation of the machine, and may even do minor maintenance work on it. The machine operator can save you time and effort by telling you of any machine irregularities.

Mechanical Troubleshooting

1.22 As a mechanical troubleshooter, you will work on mechanical, hydraulic, and pneumatic systems and their components. These systems include the plant's heating, ventilating, and air-conditioning, refrigeration, and steam-generation equipment. You will also troubleshoot drive components, including gears, pulleys, couplings, clutches, bearings, and speed reducers.

1.23 When troubleshooting a machine, you should first read the equipment record. An example of one is shown in Fig. 1-3. Then check the power supply to make sure it is operating properly. If the drive components are isolated from the rest of the machine, you can run the drive without putting the machine in gear.

1.24 If the drive is not at fault, put the machine in gear to make sure all the mechanical components are receiving the power needed to drive them. Operate the various controls on the machine to make sure they engage and disengage various parts of the machine properly. If they are not working properly, notify a technician familiar with hydraulics or pneumatics.

Fig. 1-3. Equipment record

EQUIPMENT RECORD

TAG NO. 714		OLD PL. NO.	
TAG LOCATION		EQUIP. LOCATION	Sewage Plant–East yard
MFG. Acme Ritchie Corp.		VENDOR	Acme Ritchie Corp.
MFG. SERIAL NO. 5-496	P.O. NO. 73-607	DATE 2/15	COST $6,485
JOB NO.	PA. SERIAL NO.	FLOW DIA. BOOK NO.	CAT. NO.

DESCRIPTION OF EQUIPMENT	SPARE PARTS IN STOCK PART NO.	PART NAME
Sewage screenings grinder for in-plant waste water treatment	A-2529	Morse silver chain
		6' - 6" long
Capacity, 2500 lb per hr – Instantaneous charge, 24 lb	A-3033	Dodge clutch disc No. 433x
Main shaft speed, 1800 RPM. Motor horsepower, 25.	88848	Reversible hammers (set of 48)
NOTE: For flushing water control, grinder has 3/4"		
2-way normally closed solenoid valve		
interlocked with starter.		
Flushing water rate, 12,500 GPM.		

DRAWING NO.	TITLE
777 x 25	Fixed searing assembly
126 x 709	Floating bearing assembly

Fig. 1-4. Maintenance specialists read a schematic

1.25 You should also look for leaks in lines that control the machine. Make sure the machine has all the supplies it needs to operate properly. For example, a packing machine needs a supply of metal straps or cords, and a parts packing machine requires an adequate supply of materials to pack.

1.26 If the lines are not leaking and the machine has adequate supplies, listen for unusual noises. Noise may indicate a lack of lubrication, chipped or broken gear teeth, or excess vibration. You should also note odors that might signal a lack of lubrication or burning insulation in an electrical switchbox. Feel the housings of the bearings to make sure they are not running hot.

1.27 When troubleshooting systems, always read the schematics and drawings, as the workers shown in Fig. 1-4 are doing. These diagrams will help you understand how the system works. Then try to locate specific areas that might be causing the problem. Evaluate the maintenance records and troubleshooting charts to determine possible causes of the problem.

1.28 You should check pressures in the various systems and make sure the electrical power is turned on. Check to make sure any filters are not clogged and that valves, actuators, and other components are working properly.

1.29 Study a hydraulic system's schematic diagram, maintenance record, and troubleshooting charts before testing the system. Then inspect the hydraulic reservoir to make sure it is filled with fluid to the proper level. Examine the lines and filters for sludge and check the pressure readings on the pumps. They should not be running hot. Finally, test the system in all running modes.

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.

1-1. The process of finding and correcting the cause of machine or equipment failure is called _____.	1-1. TROUBLESHOOTING Ref: 1.01
1-2. You acquire the skills to be a good troubleshooter through _____, _____, and _____.	1-2. EDUCATION; TRAINING; EXPERIENCE Ref: 1.04
1-3. What are the two major causes of machine and equipment failure?	1-3. INCORRECT MAINTENANCE, BUILT-IN DEFECTS Ref: 1.06
1-4. You should not attempt to repair a malfunctioning machine when doing so may void its _____.	1-4. WARRANTY Ref: 1.07
1-5. A simple line diagram that shows how a system works is called a(n) _____.	1-5. SCHEMATIC Ref: 1.15
1-6. An electrical troubleshooter uses a(n) _____ to measure the current in a conductor.	1-6. AMMETER Ref: 1.18
1-7. Before troubleshooting a machine, you should first read its _____.	1-7. EQUIPMENT RECORD Ref: 1.23
1-8. In troubleshooting a hydraulic system, the first component to check is the _____.	1-8. HYDRAULIC RESERVOIR LEVEL Ref: 1.29

Electrical Troubleshooting

1.30 An electrical troubleshooter works on many kinds of electrical, electromechanical, and electronic equipment. As an electrical troubleshooter, you might work on all the electrical equipment in a plant. Or you may specialize in electronic devices and instruments.

1.31 Whatever your area of special skill in electricity, you will work mainly with equipment that starts, stops, and controls the operation of equipment. You will also be called when there is a problem with the plant lighting or power distribution system.

1.32 Before troubleshooting any electrical system, you must study the proper section of the system's schematic diagram. To solve the problem quickly and effectively, you must locate the section of the circuit that is malfunctioning, and then find which component is defective.

1.33 Electrical troubleshooting cannot be done by trial-and-error, or by randomly checking components. Some modern electrical equipment—like that shown in Fig. 1-5—is very complex. You must use a logical, step-by-step approach, and have a basic knowledge of electrical theory and machine operation. The best approach is to check one component at a time in a systematic way.

Importance of Maintenance

1.34 Many people think maintenance means just repairing a device or machine and returning it to service after a breakdown. But good maintenance is much more. Regular maintenance keeps a plant and its costly equipment producing effectively and economically on a day-to-day basis. It also extends the service life of the equipment.

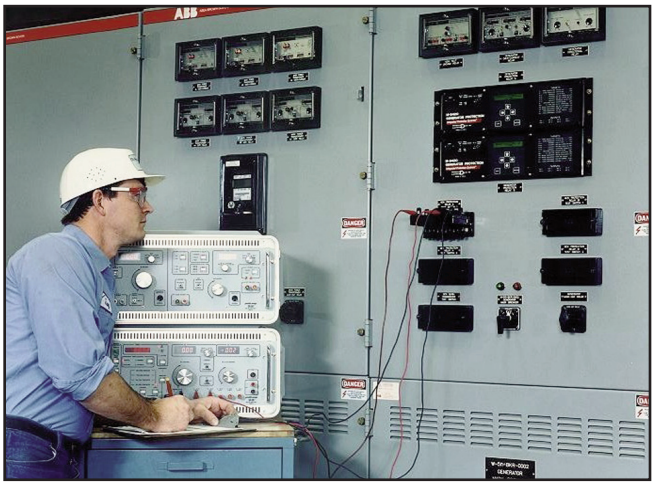
1.35 The maintenance department in a plant performs routine inspections and planned maintenance to keep equipment operating. It also does breakdown maintenance to get faulty equipment back in operation.

1.36 Keeping a plant clean, properly protected, and operating efficiently is a carefully scheduled, full-time job. As a maintenance specialist, you will use the best tools and equipment available in order to do a good job. Figure 1-6 shows part of a well-equipped maintenance shop.

1.37 Maintenance is an important part of the operation of every industrial plant. Management expects the maintenance department to operate with the same efficiency as other plant departments.

1.38 The maintenance department's duties vary from plant to plant. In some plants, the maintenance department is limited to making simple repairs and replacing defective equipment. But in other plants, the maintenance department is responsible for major jobs. Examples include building an addition to the plant and installing a major new production system. In still other plants, the maintenance department plans building and equipment changes, but outside contractors do the actual work.

Fig. 1-5. Complex electrical equipment



Maintenance Organization

1.39 To perform its work properly, the maintenance department must be organized to provide services that meet many different needs of a variety of equipment. Figure 1-7 shows the organization of a small plant maintenance department. Its staff consists of a mechanic, an electrician, and a carpenter. They report directly to the plant engineer. When needed, extra workers are borrowed from the production department.

1.40 In some companies, the head of the maintenance department may report to the head of the engineering department. In others, the maintenance supervisor reports to the production manager. Other com-

Fig. 1-6. Well-equipped maintenance shop

panies organize their maintenance departments around a master mechanic, who reports directly to the plant superintendent.

1.41 Many large companies with costly equipment and much maintenance work are organized as shown in Fig. 1-8, on the following page. A large maintenance department may include machinists, mechanics, electricians, pipefitters, painters, carpenters, guards, firemen, janitors, and even landscape gardeners.

1.42 Your maintenance department may be organized in any one of three ways—central organization, area organization, or departmental organization. The type of organization depends on which will provide better service in your plant.

1.43 Figure 1-9, on page 13, shows an example of the *central maintenance organization*. In it, the maintenance specialists report to craft supervisors and are assigned to work in all plant departments. Special equipment and specialists with special skills can be used effectively throughout the plant.

1.44 One person, the general maintenance supervisor, is responsible for all plant maintenance. A disadvantage of the central system is that any maintenance specialist may be sent anywhere in the plant. Thus, time is lost waiting for instructions, getting tools, and going to the job.

1.45 In *area maintenance*, shown in Fig. 1-10 on page 14, each maintenance specialist reports to an area maintenance supervisor and is assigned to work only in a certain area of the plant. Less time is spent between the issuing of a work order and the completion of a job, because the maintenance specialist can get tools and go to the job faster. A disadvantage is that major repairs are sometimes difficult to handle without help from other area maintenance groups or specialists.

1.46 In *departmental maintenance*, workers are assigned to a specific plant department or job. They

Fig. 1-7. Maintenance organization of small plant

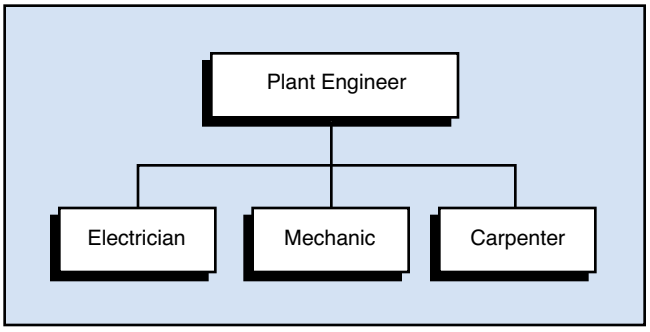


Fig. 1-8. Maintenance organization in a large plant

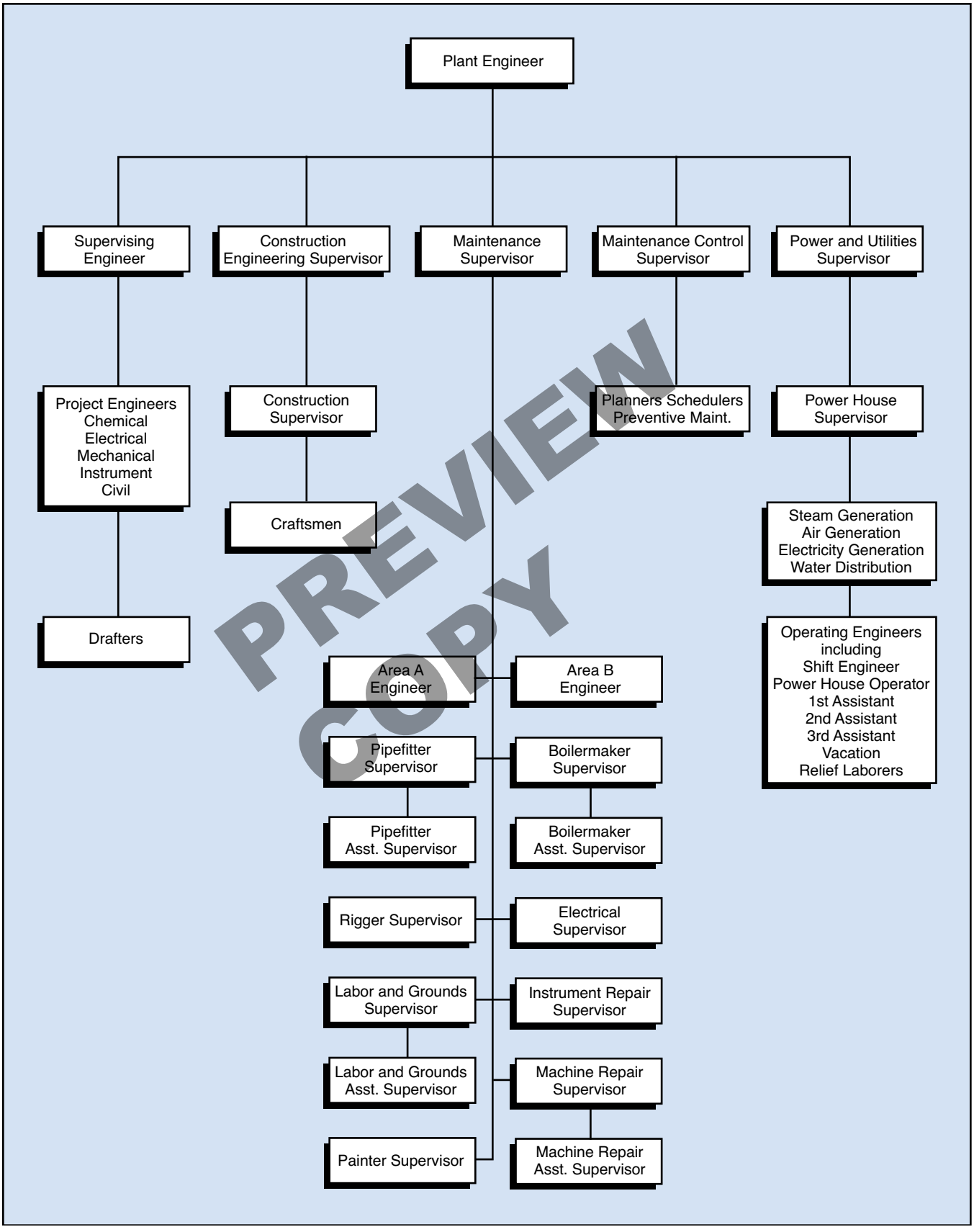
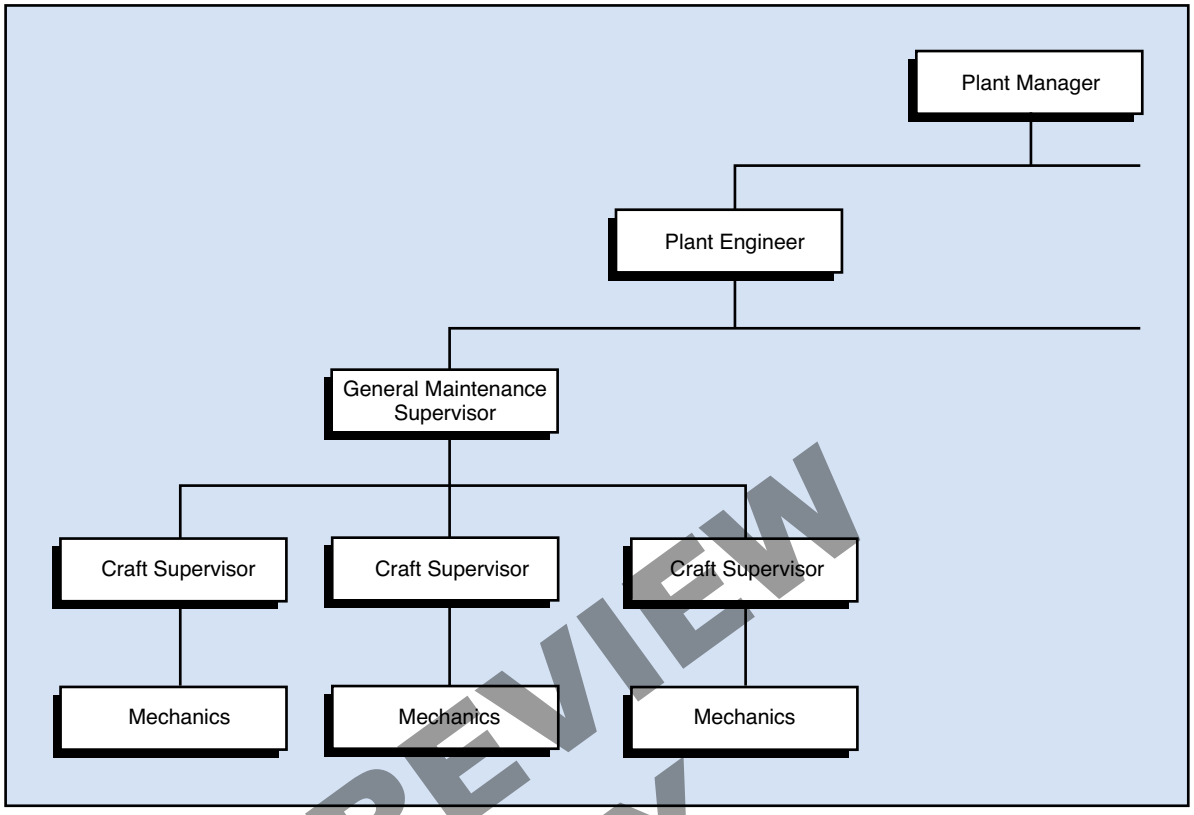


Fig. 1-9. Central maintenance organization



report directly to the department's production supervisor, as shown in Fig. 1-11 on page 15. The advantages of this system are similar to the advantages of area maintenance. A disadvantage is that additional help is not as fast or easy to get as when the maintenance specialists all report to a general maintenance supervisor.

Maintenance Personnel

1.47 The maintenance department is made up of workers skilled in the various trades needed to service production or processing equipment. The department may be subdivided into smaller groups, for example, routine maintenance, building maintenance, housekeeping, and security.

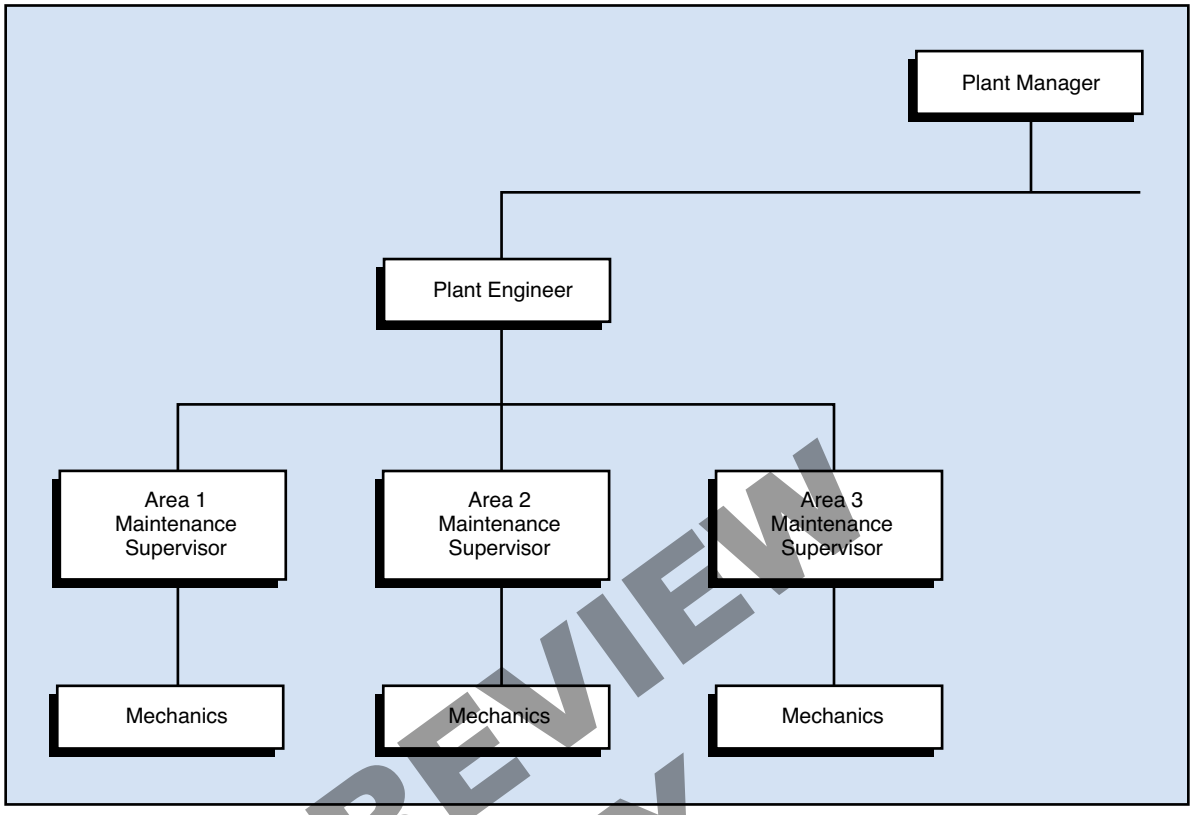
1.48 In a large plant, the production-machinery group may be further divided by trades into mechanical and electrical. The building-maintenance group may be split into electricians, mechanics, plumbers, carpenters, and painters. The housekeeping department may have janitors, sweepers, window washers, washroom attendants, and office cleaners.

1.49 In some plants, *internal engineering groups* are assigned to the maintenance department. These groups design and plan changes in production lines, buildings, and equipment. Such departments may include electrical, mechanical, production, and industrial engineers, plus architects.

1.50 Many maintenance departments include *millwrights.* A millwright's skills are many and varied, like a "jack-of-all-trades." In a large maintenance department, the millwright may be mainly responsible for installing or moving machinery. In a small plant, the millwright may have a wider variety of duties. For jobs beyond his capabilities, the millwright gets help from other specialists, either from other departments in the plant or from outside contractors.

1.51 Machinists, mechanics, welders, riggers, steamfitters, pipefitters, and carpenters make up the machinery maintenance group. The electrical section may have electricians, electrical and electronic technicians, instrument repair technicians, power-plant operators, and distribution electricians and linemen.

Fig. 1-10. Area maintenance organization



Scheduling

1.52 While other departments with a given workload can plan and organize their work, the maintenance department is a one-of-a-kind plant operation. Its work cannot be scheduled accurately, because daily work demands cannot always be determined in advance.

1.53 Many obstacles interfere with the precise planning and scheduling of maintenance tasks. Sudden breakdowns or malfunctions cannot be predicted. An inoperative machine must be repaired quickly and put back into operation. The maintenance department must remain flexible enough to handle emergencies as they arise.

1.54 Maintenance specialists often must work as a team, because no individual worker can know and do everything. In addition, many jobs require more than one person. Working as a team means coordinating people, skills, and equipment.

1.55 Planning and scheduling are the first and most important steps toward creating a good maintenance organization and achieving quality performance. Scheduling involves planning the availability of workers, material, and equipment to complete a job in the shortest possible time.

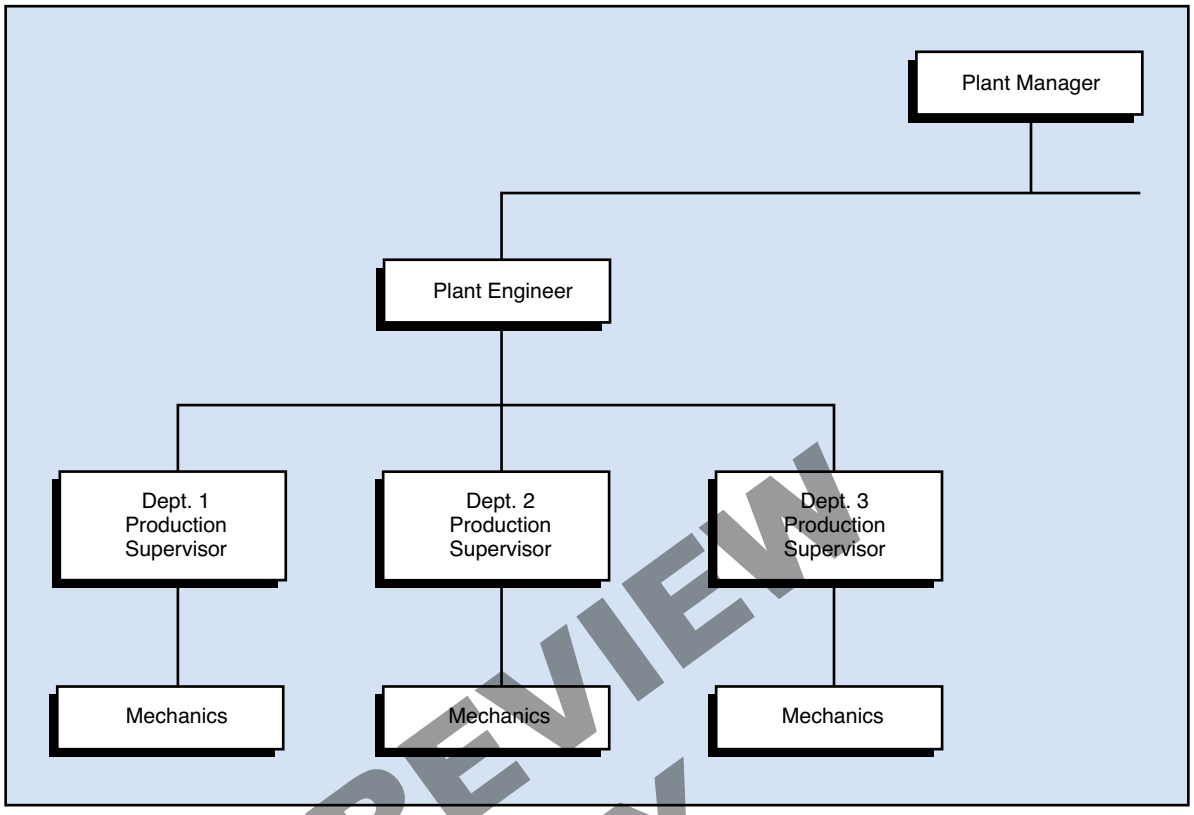
1.56 It is important that company officers, department heads, and workers be informed of progress on jobs that affect them. If a job is behind schedule, you should advise your supervisor about the delay as soon as possible. The supervisor will tell those affected by the delay, so they can adjust their schedules.

Challenge of Maintenance

1.57 Constantly changing assignments are what make maintenance work both interesting and challenging. As a maintenance specialist, your work location may change daily, or even hourly. The jobs may be similar, but the details vary.

1.58 There is little in maintenance work that is routine. The jobs differ with each piece of machinery. You will see the results of your skills and efforts throughout the plant, and take pride in knowing that you are contributing to its smooth operation.

Fig. 1-11. Departmental maintenance organization



1-9. A(n) _____ troubleshooter works mainly with equipment that starts, stops, and controls the operation of equipment.	1-9. ELECTRICAL Ref: 1.31
1-10. How many components should you check at a time in electrical troubleshooting?	1-10. ONLY ONE Ref: 1.33
1-11. Keeping a plant clean, protected, and operating efficiently is the job of the _____ department.	1-11. MAINTENANCE Ref: 1.35, 1.36
1-12. Name the three types of organization for a maintenance department.	1-12. CENTRAL, AREA, DEPARTMENTAL Ref: 1.42
1-13. In a(n) _____ maintenance organization, a maintenance specialist reports to an area maintenance supervisor, and is assigned to work only in a certain area.	1-13. AREA Ref: 1.45
1-14. In a(n) _____ maintenance organization, a maintenance specialist reports to the production supervisor.	1-14. DEPARTMENTAL Ref: 1.46
1-15. A(n) _____ is a “jack-of-all-trades” maintenance worker.	1-15. MILLWRIGHT Ref: 1.50
1-16. What are the first and most important steps toward creating a good maintenance organization?	1-16. PLANNING, SCHEDULING Ref: 1.55

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

1-1. To locate the probable cause of an equipment malfunction, the skilled troubleshooter

- ☐ a. calls in a technician
- ☐ b. follows a plan
- ☐ c. randomly tests various components
- ☐ d. takes the machine apart

1-2. Before calling the manufacturer to make a machine repair, you should

- ☐ a. disassemble the part and inspect it
- ☐ b. get a second opinion from a coworker
- ☐ c. make a substitute part for the machine
- ☐ d. see if you can make the repair

1-3. Basic electrical troubleshooting equipment includes

- ☐ a. flowmeters
- ☐ b. multimeters
- ☐ c. thermometers
- ☐ d. thickness gauges

1-4. You can often get information on the problem with a machine by asking the

- ☐ a. machine operator
- ☐ b. maintenance foreman
- ☐ c. manufacturer's representative
- ☐ d. production manager

1-5. On which kind of system does a mechanical troubleshooter *not* work?

- ☐ a. Electronic
- ☐ b. Hydraulic
- ☐ c. Mechanical
- ☐ d. Pneumatic

1-6. The first step in troubleshooting a machine is to

- ☐ a. check the power source
- ☐ b. listen for unusual noises
- ☐ c. operate the various controls
- ☐ d. read the equipment record

1-7. The best approach to electrical troubleshooting is to

- ☐ a. memorize the locations of components
- ☐ b. randomly check electrical components
- ☐ c. rely on schematics
- ☐ d. systematically check one component at a time

1-8. In a central maintenance organization, a maintenance specialist works

- ☐ a. for the production supervisor
- ☐ b. in a specific department
- ☐ c. in all plant areas
- ☐ d. only in a certain plant area

1-9. In a large plant, electricians, mechanics, plumbers, carpenters, and painters make up the

- ☐ a. building-maintenance group
- ☐ b. housekeeping department
- ☐ c. internal-engineering group
- ☐ d. production-machinery group

1-10. Mechanics, welders, steamfitters, pipefitters, and carpenters are part of the _____ group.

- ☐ a. building-maintenance
- ☐ b. internal-engineering
- ☐ c. machinery-maintenance
- ☐ d. production-machinery

SUMMARY

Troubleshooting is the process of detecting and diagnosing the probable cause of a machine or system malfunction, and eliminating it. People who perform this job are called troubleshooters. Troubleshooters are part of the maintenance department.

Troubleshooters are skilled technicians who work according to a logical, step-by-step plan. They acquire their skills through education, training, and experience. Troubleshooters are vital to a plant's operation, because they keep machines and equipment operating. This allows the plant to be productive and competitive.

Troubleshooters in small plants work on a variety of mechanical and electrical equipment. In large plants, troubleshooters may work only on specific types of equipment. All troubleshooters use troubleshooting aids and test equipment to help them in their work.

Regular plant maintenance is an important part of troubleshooting. A department must be well-organized to be efficient and effective. It may be organized according to a central, area, or departmental system. The best organization is the one that provides the best service.

Answers to Self-Check Quiz

1-1. b. Follows a plan. Ref: 1.02

1-2. d. See if you can make the repair. Ref: 1.08

1-3. b. Multimeters. Ref: 1.17

1-4. a. Machine operator. Ref: 1.21

1-5. a. Electronic. Ref: 1.22

1-6. d. Read the equipment record. Ref: 1.23

1-7. d. Systematically check one component at a time. Ref: 1.33

1-8. c. In all plant areas. Ref: 1.43

1-9. a. Building-maintenance group. Ref: 1.48

1-10. c. Machinery-maintenance. Ref: 1.51

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