

DW Module 10:
General Maintenance
Answer Key



What are some factors that impact the availability of equipment? (What causes "downtime"?)

- *Human Error*
- *Acts of God or Nature*
- *Product Defects*
- *Planned Service Work*



What are some factors that help to ensure high availability of equipment (minimal "downtime")?

- *Continuous Monitoring and Assessment of Equipment*
- *"Real Time" Knowledge of Equipment Condition*
- *Analysis of Other Information, such as Equipment History, Operational Protocols, and Manufacturer's Data]*

UNIT 1 EXERCISE:

1. List three of the five goals of a drinking water plant's maintenance program.

Ans: fixed asset management; maintenance of design intent; efficiency of operation; safety and environmental protection; and system reliability

2. Explain why the banker or municipal residents are concerned about plant maintenance.

Ans: (possible answer) He/She/They want to protect their investment.

3. List three items that require daily maintenance. List two that require periodic screening and rare maintenance.

Ans: (Various answers available)

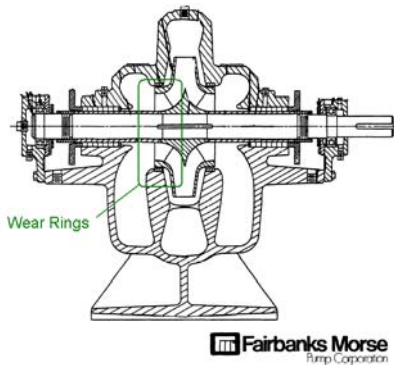
4. How does regular maintenance impact the availability of personnel?

Ans: Management knows how many people to assign to various tasks; keeping crises to a minimum, through regular maintenance, means that staffing is not "hit or miss" but is planned and organized.

5. Give three examples of the ways in which plant maintenance directly impacts the quality of drinking water produced at the plant.

Ans: Possible answers include valves, meters that read quality standards, equipment that responds to the metered data, etc.

6. What could happen if a pump were allowed to operate with excessively worn wear rings?



Ans: Possible answers include lower pump efficiency; higher power consumption; need for more capacity placed online; increased burden on electrical system

Figure 1.2 Wear Rings



What maintenance tasks might a plant operator in a small facility complete?

[Ans: *Various answers are possible. The overall theme is that operators in a small facility will probably complete many types of maintenance on a routine basis.]*



What maintenance tasks might a plant operator in a large facility complete?

[Ans: *Various answers are possible. The overall theme is that operators in a large facility will probably have a maintenance staff that does most of the maintenance tasks. However, the operator will make some minor adjustments, monitor equipment, and so forth.]*



Why does it make sense to involve operators in the maintenance plan of any facility?

[Ans: *The operators, of course, are involved in the everyday functioning of equipment and systems. They know the equipment well and know how it should perform. They can quickly notice any changes in performance. Also, it makes sense to think that operators know what works in the "real world" environment, as opposed to what works on the design table. Their input is valuable to the maintenance plan.]*



Review the definition of SOPs.



SOPs help a facility to comply with mandated standards. For example, the United States Department of Environmental Protection (US DEP), through its Safe Drinking Water Act (SDWA) sets limits for certain contaminants in drinking water. How might a facility's SOPs ensure compliance with these requirements?

[Ans: Various answers are possible. SOPs ensure that equipment is kept functioning properly, that reports are collected and analyzed, that meters can read the data, and so forth.]

Preventive Maintenance as the Key Effort



What are some examples of PM that are performed at the facility in which you work? How often are the tasks performed?

[Ans: Various answers are possible; answers vary according to the size and type of facility. Some examples include: adjusting packing gland on a pump seal; checking and recording pressure gauge readings for pumps, exercising valves as part of a semi-annual valve program.]

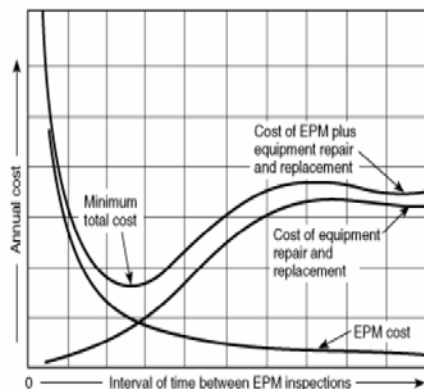


What consequences could you imagine if the PM work was neglected for a long time?

[Ans: Various answers are possible, including equipment failure, higher costs, lower available labor pool, operation-wide failures, etc.]



Look at the graphic below and determine how EPM (electrical preventive maintenance) recommendations are related to costs. Does more maintenance automatically equal less cost? When does the cost of maintenance lower the cost of other problems?



[Ans: When the EPM cost is lowest (for example, we are doing the minimum service and inspection) the operating and repair cost will be greatest. In virtually all cases when talking about major plant equipment, overall costs will be less if we do preventive maintenance. Insufficient PM can result in unplanned shutdowns (unpredictable and disruptive), emergency repairs (always costly) and catastrophic failures (possibly resulting in loss of life and property).]

Many maintenance people comment that, when a good PM plan is in place, their job is boring because the work is predictable and things do not break down. But, that is the type of operation management wants. By the same token, if we perform excessive PM, the costs can exceed the benefits. This is due to a waste of manpower and the replacement of items like belts, filters, and replacement parts when they are not really needed. A more subtle concern is that, statistically, the more we "touch" a piece of equipment the greater the chance of adversely effecting its operation.]

Corrective Maintenance



What are some examples of corrective maintenance that are performed at the facility in which you work?

[Ans: Various answers are possible. Some include: adjustment of pump/motor alignment after excessive vibration was observed; lubrication of a roller bearing on a conveyor after noise was detected; replacement of an air filter after excessive differential pressure across the filter was observed.]



How do you identify the items in need of corrective maintenance?

[Ans: Various answers are possible. Some include: visual inspection; noise patterns; vibration analyses.]

Breakdown Maintenance



What are some examples of breakdown maintenance that are performed at the facility in which you work?

[Ans: Various answers are possible. Some answers include: replacement of a motor after it overheated and failed; rebuilding a clarifier gear case after oil leaked and gears were damaged from lack of lubrication.]



Thinking about the examples you have heard in class, what other types of maintenance, if any, could have prevented the breakdown maintenance?

[Ans: Various answers are possible, according to the answers given to the previous question. In most cases, regular preventive maintenance and timely corrective maintenance will prevent the need for breakdown maintenance.]

NOTE: Various answers are possible in all categories. Sample answers are provided below.]



List some maintenance activities that occur at your plant during these time frames:

- **Daily**

[Ans: Pump operation (noise, vibrations, smell); tank levels.]

- **Weekly**

[Ans: Meter readings; check maintenance reports to tweak equipment or order chemicals.]

- **Monthly**

[Ans: Check hours of operation (unit may need periodic servicing); check for animals and rodents; clean the sampler; check filters.]

- **Quarterly**

[Ans: Change out or rotate equipment; generate extra testing as needed; perform required testing from Permit or Regulatory Agency; check, clean, or change HVAC filters; check, clean, or change process filters.]

- **Annually**

[Ans: Check and service all equipment on its yearly anniversary; check large gear cases, motors, and comminutors; inspect vehicles.]

- **Seasonally**

[Ans: Exterior building inspection (cracks, remove wind screens, etc.); change oil viscosity where needed; perform roof inspection; check and make adjustments for changes in seasonal discharge requirements.]



How does your facility plan for the unplanned? What resources are available to deal with emergencies?

[Ans: Various answers are possible. Students may state that their facility has spare parts on hand, duplicates equipment, or has redundant operations.]



Why might outside contractors work on larger new installations?

[Ans: Outside contractors may have more expertise; liability issues; in-house staffing constraints; timing of the project.]



What is the object of equipment overhaul?

[Ans: Overhaul incorporates major revisions, including cleaning, repair, replacement parts, and updating.]



What input should an operator have in assessing the need for overhauls?

[Ans: Does the unit work as it is intended? Does it meet the facility's needs? Are repairs more constantly needed? Is there a better functionality available?]

UNIT 2 EXERCISE:

1. A chart that clearly defines roles and responsibilities and the reporting structure where you work is called a organization chart.
2. SOP means a standard operating procedure or guideline that was established by management to ensure that the facility's practices conform to internal and external requirements.
3. A CMMS, which is short for computerized maintenance management systems allows the creation of a database of information about your facility, can track regular and preventative maintenance work orders and bring order to the execution of maintenance work.
4. List the three main reasons for contracting work to be done by outside personnel:
 - a. Balanced work load
 - b. Organization's size
 - c. Specialized work
5. Breakdown (or reactive) maintenance often occurs when there is a failure of preventative and corrective maintenance.
6. Preventive maintenance is the heart of any maintenance plan.
7. Corrective maintenance has the goal of preventing further damage to equipment that has suffered some ill effect.
8. Repairing a broken drive chain and adjusting tension in a belt would be examples of unplanned daily activities.
9. Plant modernization and installation of new equipment are examples of planned project work.
10. Data gathering and retention is an example of record keeping



Looking at the picture, how many types of identification systems can you find?



[Ans: Various answers are possible. Be sure the students see, at a minimum, the following tags: function (in blue duct tape); manufacturer's number (black plastic tag); facility's pump number (written on the equipment with a marker); components (duct tape).]



What are the possible consequences of this kind of labeling?

[Ans: Various answers are possible. Make sure students note, at a minimum: safety issues; confusion when identification is required.]



In the following activity, you will create three types of tagging systems. Using the equipment listed below, create a Number Code, Alpha-numeric Code, and Smart Number Code for each of the products.

Number Code:

[Ans: Various answers possible. The earliest purchases should have the lowest number. An example:

Trash Rack (Bruning facility)	2355
Trash Rack (Main Street facility)	2356 (this was bought the same day as the other trash rack; therefore, it is probably tagged with the next available number)
Backwash Pump	4200 (this was purchased two years after trash racks)
Air Filter	5203 (this was purchased the year after the pump)]

Alpha-numeric Code:

[Ans: Various answers are possible. The earliest purchases will have a lower number, according to the type of equipment. An example:

Trash Rack (Bruning facility)	TR2355 (TR stands for trash rack in this example)
Trash Rack (Main Street facility)	TR2356 (this was bought the same day as the other trash rack; therefore, it is probably tagged with the next available number)
Backwash Pump	BP4200
Air Filter	AF5203]

Smart Number Code:

<i>(Trash Rack (Bruning facility)</i>	<i>TR032355 (TR stands for trash rack in this example; 03 is the facility; and 2355 is the identification number)</i>
<i>Trash Rack (Main Street facility)</i>	<i>TR042356 (TR stands for trash rack; 04 is the facility; and 2356 is the identification number, indicating it was the purchase made directly after the previous trash rack purchase, therefore, it is probably tagged with the next available number)</i>
<i>Backwash Pump</i>	<i>BP024200 (BP stands for backwash pump; 02 indicates the Lee Highway facility; 4200 is the identification number for this piece of equipment)</i>
<i>Air Filter</i>	<i>AF045203 (AF is Air Filter; note that the next two digits, 04, are the same as the trash rack in the Main Street facility; the 04 indicates the location of the equipment)]</i>

UNIT 3 EXERCISE

1. What equipment information is important to gather when making a master equipment list?
 - a. Type of equipment
 - b. Quantity
 - c. Model Number
 - d. Capacity
 - e. Electrical Characteristics
 - f. **All of the above**
2. All pieces of equipment should receive a unique **identification** code.
3. The acronym SOP stands for
 - a. "Standard Osmosis Protocol"
 - b. **"Standard Operating Procedure"**
 - c. "Simulated Operation Procedure"
 - d. "Standards of Practice"
 - e. None of the above

4. In developing a maintenance schedule, it is important to understand how often certain tasks should be performed and how long each task takes.
 5. Maintenance departments can help to justify their staffing needs by accurately listing what equipment is on site, create a library of procedural tasks, determine how often each task needs to be done and how long it takes to do.
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Unit 4 Exercise

1. Which of following are known to increase the life of a centrifugal pump (Select all that apply)
 - a. Only allow the pump to run for short periods of time
 - b. Allow the pump to run for longest time possible before shutdown
 - c. Follow manufacturer's recommendation for how many times per hour a pump should be started
 - d. A pump should be started a minimum of 5 times per hour
2. Which of the following should be part of regular maintenance on a centrifugal pump? (Select all that apply)
 - a. Oil the bearings
 - b. Repack the shaft seal
 - c. Loosen the chain drive
 - d. Spray WD-40, or equivalent, into the relief plug
3. Of the following, which one is the most precise way to assess the condition of a centrifugal pump?
 - a. Amperage
 - b. Listening to the sound of the pump
 - c. Measuring flow
 - d. Vibration analysis
4. True or False: Valves should be exercised on a daily basis.
5. The following can be used to test an electric motor: (Select all that apply)
 - a. Resistance testing
 - b. Negative earth test
 - c. Vibration analysis
 - d. Ground fault test
6. (Fill in the blank) Periodically electrical terminals and bulbar connections must be _____.
 - a. Unscrewed
 - b. Re-torqued
 - c. Greased
 - d. Painted
7. _____ is a good way to determine the condition of electrical equipment using a hand-held scanner.

- a. Computer testing
- b. Cold testing
- c. Thermographic testing
- d. Chromatography testing

8. What two items are commonly checked on a diesel engine by water system staff? (Select all that apply):

- a. The coolant
- b. Engine management computer
- c. The lubricating oil
- d. Hydraulic lifters