Need-to-Know Criteria

For

Maintenance Technologists School

Class 1

Revised MAY 2010

Suggested Reference Materials for Class 1

- Either of one (1) of these three California State University (CSUS), Sacramento (SAC) Foundation, Office of Water Programs
  - Operation of Wastewater Treatment Plants, Volume II (WW SAC)
  - Industrial Waste Treatment, Volume II (Ind W SAC)
  - Water Treatment Plant Operation, Volume II (W SAC)
- Arasmith Consulting
  - Pumps and Pumping (PP)
  - Electrical Fundamentals for Water and Wastewater (EFWW)
- Code of Federal Regulations (CFR), Title 29, Part 1910 Occupational Safety and Health Standards - Available at: www.osha.gov; (click on “Regulations” and choose “Part 1910” from the list)
**Materials, Tools and Lubrication**

1. Required material selection to include:
   a. Adhesives – types and uses.
   b. Anti-seize compounds – Purpose and selection.
   c. Coatings/Paints – Selection, quality, and surface preparation.
   d. Epoxy – types, purpose, uses, and surface preparation.
   e. Fastening devices – Bolts, nuts, washer types and styles, and screws.
   f. Gaskets – Gasketing materials, material compatibility, selection, and proper torque.
   g. Locking compounds – Importance of compounds and proper selection.
   h. Metals – Carbon steel, stainless steel, brass, bronze, copper, aluminum, zinc, and composite materials.
   i. O-rings – Sizing, selection, and material compatibility.
   j. Plastics – Selection of materials and compatibility.
   k. Sealants – Types and uses.
   l. Shims – Styles and uses.
   m. Solvents – Types and uses.

2. Required knowledge of materials:
   a. Application procedures – proper assembly techniques and importance of being thorough.
   b. Corrosion control – using coatings and paints to minimize corrosion.
   c. Material compatibility – Use of compatibility charts for making sure that systems are adequately designed so dissimilar properties are minimized.
   d. Material Safety Data Sheets –
   e. Storage procedures – Safe and proper storage of tools, materials, chemicals, and lubricants.

3. Required use of tools:
   a. Calibration equipment – understand and identify types of equipment.
   b. Electrical instruments – Use of and understanding electrical instruments.
   c. Hand Tools – Identify and understand basic use pliers, wrenches, hammers, screwdrivers, chisels, probing tools etc.
   d. Hoists/Cranes –
   e. Ladders –
   f. Machining Equipment – Identify lathes, milling machines, and drill presses and be familiar with the uses of them.
   g. Power Tools – Identify and safely use electrical, air, and battery powered tools.
   h. Pressure/Hot Water Washers – Safely use and identify the types of steam and pressure washers.
   i. Rigging – Gathering data, estimating weights, and properly and safely moving loads.
   j. Scaffolds –
   k. Sand Blasters – Be aware of sandblasting waste and associated disposal procedures.
   l. Solvent Tanks – Identification, proper use, and safety latches.
   m. Welding/Cutting Equipment – Use of hot work permits.

4. Required use of precision tools:
   a. Alignment – Tools associated with alignment of shafts, belts, sheaves, sprockets, and chains.
   b. Calipers – Checking alignment and related components using calipers.
   c. Dial Indicator – Use of dial indicators to check for and correct misalignment.
   d. Laser – Using the laser alignment methods to check for and correct misalignment.
   e. Micrometer – Using micrometers to check for and correct misalignment.
f. **Feeler Gauge** – Use of feeler gauges to check for and correct all types of misalignment.

5. **Required knowledge of tools:**
   a. **Accuracy.**
   b. **Non sparking** – Proper use of and applications.
   c. **Precision** – Proper care, storage, and usage of precision tools.
   d. **Sharpening** – Importance of using properly sharpened tools.
   e. **Tool Storage** – Importance of properly storing and storage solutions. Tool cleanliness and associated safety.

6. **Required use of lubricants:**
   a. **Grease** – Proper use of and selection and identifying the problems of under and over greasing. The different bases and compounds, techniques, and manufacturer recommendations.
   b. **Oil** – Lubrication schedules, proper levels, viscosities, effects of temperature, synthetics, fire points, pour points, and flash points.
   c. **Water** – The uses of water as a lubricant and for cooling.

7. **Required knowledge of lubrication: Ref.**
   a. **Food Grade Lubricants** – Applications and proper selection.
   b. **Grades of lubricants** – Viscosities and single weights versus multi-weight oils.
   Grease selection will also be covered.
   c. **Load** – Pairing of loads and pressures with lubricants.
   d. **Lubrication systems** – Recognizing the styles of systems and dealing with problems and issues associated with them.
   e. **Manufacturer Requirements** – Understanding lubricant and equipment recommendations and making the best choices.
   f. **Petroleum based lubricants** – The ups and downs of using the petroleum products.
   g. **Product Compatibility** – Using lubricant charts to determine compatibility among products.
   h. **Sampling** – Advantages and disadvantages of analysis.
   i. **Scheduling** – Setting up PM schedules using lubricant and equipment manufacturer specifications.
   j. **Synthetic based lubricants** – Advantages and disadvantages of using synthetics.
   k. **Temperature** – Effects temperatures have on lubricants. Knowing the importance of the pour, flash, and fire points.
   l. **Purpose** – Reduction of heat and friction in mechanical systems.

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**Pumps**

1. **Required Knowledge of Pump Operations.**
   a. **Understanding Air Binding**
   b. **Pump Cavitation**
   c. **Operation against a closed valve**
   d. **Pump Curve**
   e. **Pump Efficiency**
   f. **Pump Hydraulics**
   g. **Reverse Rotation**
   h. **Water Hammer/Surge**
   i. **Flush/Seal Water**

2. **Required Knowledge of Pump Components**
   a. **Pump Categories**
   b. **Pump Types**
   c. **Pump Shaft Seals**
   d. **Pump Shaft Sleeves**
   e. **Slinger Rings**
   f. **Stuffing Boxes**
### Rotating Components

#### 1. Required Knowledge of Bearings and Bushings
- a. Types of Bearings and Bushings
- b. Inspection of Bearings and Bushings
- c. Mounting and Dismounting Procedures
- d. Lubrication methods
- e. Cleaning Procedures
- f. Wear Pattern Analysis
- g. Bearing Materials
- h. Storage Procedures

#### 2. Required Knowledge of Shafts
- a. Axial Alignment
- b. Bearing Fit
- c. Coupling Techniques
- d. Shaft Run out
- e. Out of Roundness
- f. Wear Patterns
- g. Vibration Analysis
- h. Storage Procedures

### Motors and Drives

#### 1. Knowledge of inspection procedures for the following devices:
- a. Actuators
- b. Belts
- c. Brakes
- d. Chains
- e. Clutches
- f. Drive Couplings
- g. Drive Shafts
- h. Gearboxes
- i. Gears
- j. Universal Joints
- k. Variable Speed Belt Drives

#### 2. Basic knowledge of how these devices and concepts operate and are used in plants:
- a. Alignment
- b. Anti-reverse Ratchets
- c. Carrier Bearings
- d. Gear Lash
- e. Gear Ratios
- f. Guards
- g. Harmonic Imbalance
- h. Lock Nuts
- i. Shear Pins
- j. Torque Overload
- k. Bearings

### Pipes and Valves

#### 1. To provide a basic knowledge of valves, valve controls and hydraulics
a. REQUIRED KNOWLEDGE OF VALVE APPLICATION

i. Actuators
ii. Air release
iii. Air Vacuum
iv. Backflow Prevention
v. Isolation
vi. Level Control
vii. Pressure Control
viii. Throttling

b. REQUIRED KNOWLEDGE OF PIPING

i. Hydraulic Concepts
ii. Wrap

2. Identify and describe the proper operation, lubrication and maintenance procedures for the following valves and accessories:

a. Gate / Knife
b. Plug / Eccentric
c. Butterfly
d. Ball
e. Globe
f. Needle
g. Pinch
h. Check - Ball – Flapper
i. Sluice
j. Shear
k. Diaphragm
l. Pressure relief / reducer

3. What is the purpose and describe the difference between the following:

a. Backflow Preventers
   i. Vacuum Break
   ii. Reduced Pressure Zone
   iii. Air Gap Separation System
   iv. Double check

4. Identify the common types of pipes, fittings and connections and state the application of each in a treatment plant.

a. Ductile Iron, Cast Iron
b. Clay
c. Black Iron pipe
d. PVC / CPVC / ABS / PEX
e. Steel
f. Copper
g. Concrete
h. Stainless Steel
i. Fittings
j. Elbows
k. Tees
l. Wyes
m. Reducers
n. Sleeves
o. Adapters
p. Unions
q. Connections
r. Flanges
Safety Practices

1. Overview of general industrial safety standards
   a. REQUIRED KNOWLEDGE OF HEAVY EQUIPMENT
      i. Commercial Driver License (CDL)
      ii. Equipment Operator Certification
      iii. Safety Procedures
   b. INSPECT TANKS
   c. REQUIRED KNOWLEDGE OF TANKS
      i. Application
      ii. Cathodic Protection
      iii. Coatings, Materials
      iv. Overflow/Drain Lines
      v. Tank Access
      vi. Ventilation
      vii. Wash Down Procedure
   d. REQUIRED TO FOLLOW SAFETY PROCEDURES
      i. Chemical Handling
      ii. Confined Space Entry
      iii. Cross Connection Control
      iv. Electrical Hazards
      v. Explosion Proof Lighting
      vi. Extension Cords
      vii. Fire Safety
      viii. Laboratory Safety
      ix. Lock-out/Tag-out
      x. Traffic Control/Work Zone Safety
      xi. Trenching and Shoring Required
   e. REQUIRED KNOWLEDGE OF SAFETY PROCEDURES
      i. Amperage
      ii. Arch Flash
      iii. Certification Requirements
      iv. Combustible Gas Devices
      v. Emergency Response Plans
      vi. Fall/Retrieval Equipment
      vii. Fuel Tanks/Cans
      viii. Grounding
      ix. Job Safety Analysis
      x. Lightning Protection
      xi. Material Safety Data Sheets
      xii. Personal Protective Equipment
2. Why is safety important at water and wastewater plants (referred to as “plants” from now on)?

3. Explain the reasons for the following basic rules of good personal hygiene in plants as listed below
   a. Keep hands & fingers away from eyes, ears, nose and mouth
   b. Wearing rubber gloves
   c. Washing hands before eating and smoking
   d. Work clothes stored separately from personal clothing
   e. Give cuts and scratches first aid immediately
   f. Take a shower after work

4. What are the most common physical injuries (strains & sprains)?

5. Why is having a confined space entry (CSE) program important?

6. How is a confined space defined?

7. At what oxygen level deficiency are we concerned with in regard to CSE?

8. Understand entry and exit procedures.

9. What types of harmful gases may you encounter at the plant?

10. What should you read before using any chemicals? (MSDS)

11. Understand uses of proper personal protective equipment prior to handling any chemicals.

12. Describe electrocution hazards in treatment plants and how to eliminate them.

13. What action must be taken when electrical equipment is repaired or installed in treatment plants and the collection system?

14. What is involved in lockout / tag out procedures?

15. Understand when an electrical extension cord can be used and when it can’t.

16. Why should you inspect extension cords?

17. Good safety fire practices require knowledge of ingredients necessary for a fire, control methods and fire prevention practices.

18. Why should there be explosion proof lighting in your pump stations?

19. Why is it important to inspect your facilities for cross connections?

20. What is an “air gap”?

21. Explain why trenching / shoring is important. What is necessary in terms of slope and shoring?

22. Describe why all chemical containers should be clearly labeled.

23. Why should you always wash your hands before eating? Understand why good personal hygiene is important.

24. What does “arc flash” mean?

25. Why is it important to utilize hot work permits?

26. Basic terms of electricity, definitions: Amperage, current, voltage, resistance, power
   a. current – flow of electrons measured in amp
   b. voltage – electrical pressure measured in volts
   c. resistance – opposition to current flow measured in ohms
   d. power – work measured in watts
   e. amperage – same as current

27. What does OSHA stand for?

28. Understand why combustible gas devices are used and what gases are checked in confined space entry.
29. What types of emergency response plans are required to keep at your facilities and where should they be kept?

30. Understand the requirements for machine guarding.

31. Define the types of confined space and the hazards associated with those spaces.
   a. general confined space
   b. permit required confined space
   c. non-permit required confined space

32. Maintenance technologists must understand:
   a. potential for electric shock
   b. levels of electric current that end in fatal shock
   c. following terms: insulate, conductor, open circuit, closed circuit
   d. electrical repairs can only be made by qualified individuals
   e. site specific LO/TO policy and procedures.

33. Understand the importance of wearing proper personal protection equipment and when to use in specific situations. As a minimum, technologists should know how to use, care for and the limitations of the following:
   a. hard hats
   b. safety shoes and boots
   c. safety goggles and face shields
   d. gloves, abrasives, exposure and voltage
   e. aprons
   f. traffic vests
   g. personal floatation devices
   h. hearing protection

34. Why is ventilation important while working in limited working areas and confined spaces?

35. Why is it important to understand rescue procedures, when to call for assistance?

36. Why are jobsite hazard assessments important and when should they be performed?

37. Understand the proper use of fuel tanks and using fuel cans for transport.

38. Describe hazards commonly encountered with respect to falling and explain methods for minimizing them.

39. What agency administers OSHA in North Carolina?

40. Describe the importance of having caution signs, flotation devices, guard rails, toe plates, available PPE at various locations within the facilities.

41. Explain why the following cause oxygen deficiency in treatment plants and collection systems.
   a. poor ventilation
   b. displacement of air by another gas
   c. absorption, consumption or biological depletion by organic matter in sewers, manholes and covered tanks

42. Where should paints, varnishes and flammable liquids be stored?

43. Why is proper lighting crucial at facilities?

44. Why is good housekeeping so important?

45. What is the recommended type of fire extinguisher to have at the facilities?

46. Why should you have safety meetings? What are their purposes?

47. Understand proper techniques for lifting objects.

48. Identify steps for warning the public when there are potential traffic hazards.

49. Understand adverse weather conditions and what to do if those conditions exist.

50. Why should all chemicals be labeled?

51. Understand the proper way to remove manhole covers.

Pressure Vessels and Blowers

1. To provide a basic knowledge of compressors, blowers, boilers and associated devices
   a. REQUIRED KNOWLEDGE OF BOILERS
      i. Air Release Valve
ii. Chemical Feed
iii. Corrosion Control
iv. Low Water Cutoff
v. Pressure Relief Valve
vi. Water Chemical Analysis

b. REQUIRED KNOWLEDGE OF COMPRESSORS/BLOWERS
i. Air Dryers
ii. Constant Speed Control Systems
iii. Filters
iv. Mufflers
v. On-Off Control Systems
vi. Pressure Relief
vii. Unloader Control Systems

2. Why is it important that a boiler air release valve operates properly?
3. How to identify an Air release Valve.
4. How often should you check a Boiler Pressure Relief (POP OFF) Valve?
5. The device used to protect the blower from excessive back pressure and overload.
6. Blowers are positive displacement type or the centrifugal type.
   a. Air Metering Device
   b. Condensate Traps
c. Air Headers
   i. Fixed Heater
   ii. Swing Header
d. Diffusers
   i. Fine Bubble
   ii. Medium Bubble
   iii. Coarse Bubble
8. That the correct valves are open when starting Blowers.
9. The purpose of the boiler components.
   a. Control Valve
   b. Air Release Valve
c. Check Valve
d. Air Vacuum Release
10. Different types of Air Compressors.
   a. Screw
   b. Piston
11. Why is boiler blow down necessary and how is it done.
12. The reason for Boiler Water Chemical additives.
13. The purpose of the Low Water Cutoff Switch.
15. How to identify the following equipment.
   a. Gas drier
   b. Electric actuator
c. Air throttle valve
d. Different types of air inlet filters
e. Differential pressure gauge
f. Air flow indicator
g. Flexible drive coupling types
h. Filter type
i. Manometers
j. Air discharge silencer
k. Oil pressure gauge
1. Vibration sensors
  m. Air pressure gauges
  n. Air flow measurement
  o. Orifice plates
  p. Flexible couplings for air lines

16. How to identify the possible cause of these abnormal conditions?
   a. Bearing noise
   b. Gear noise
   c. Coupling noise or vibration
   d. Housing noise or vibration
   e. Surge

17. How to identify the characteristics of a positive displacement blower vs a centrifugal blower?
   a. Relative rpm?
   b. Constant pressure?
   c. Constant volume?
   d. Relative number of moving parts?

18. How to explain the following:
   a. The need for clean air.
   b. How is air flow controlled in a positive displacement blower?
   c. How is air temperature affected by compressors?
   d. How is air flow controlled in a centrifugal blower?
   e. What is surge?
   f. How is a blower protected from surge?
   g. Is surge possible in a positive displacement blower?
   h. Alarm set-points
   i. Filter cleaning

19. To identify the proper application for each type of blower:
   a. Constant head, variable air flow system
   b. Variable head system

20. The three main mechanical operating issues reflecting the proper operation of a blower are vibration, temperature, airflow

21. Air flow is measured in units of SCFM which stands for “Standard Cubic Feet per Minute”

20. There is a minimum rate (SCFM) of air that must flow through a centrifugal blower to allow for cooling and proper loading of the impellers.

21. Below a certain minimum rate of air, the blower will experience a condition known as Surge.

22. Surge is the point where the blower can no longer overcome the pressure in the piping, and the blower rapidly pressurizes and depressurizes. This causes excessive heat, axial load on the bearings, and possibly even internal contact.

23. Air flow rate through the blower is proportional to power. At continuous speed, as air flow (SCFM) increases, amps will also increase.

24. Surge is characterized by low amperage and airflow, increased discharge temperatures, high pressure, and possibly a rhythmic pounding or “wheezing” sound.

25. Surge is caused by a sudden reduction in airflow, either by valves or process restrictions downstream from the blower, or an excessively throttled inlet valve.

26. Most blowers have surge protection installed, that will shutdown the blower. This is typically done by monitoring the drive motor amps and shutting down the blower if the amperage falls below a certain level for a even a short period of time.

27. Oil levels should be monitored weekly when no leaks are present, and daily when there are obvious leaks.

28. The oil level must be kept within the recommended range; under filling causes failure, and overfilling causes leaks.

29. To stop the blower, press “Blower Stop”, or in an emergency press “E-stop”
30. Blower maintenance requires that these three areas are monitored:
   a. Lubrication
   b. Inlet Air Filters
   c. Couplings

31.

32. Inlet air filters are necessary to protect the blower from dirt and other foreign objects.

33. A dirty filter can greatly reduce necessary process airflow.

34. Filters should be regularly inspected for cleanliness and wear.

35. An air restriction/differential pressure gauge can be a useful tool for determining the life of a filter, but is not necessary.

36. There is typically no recommended maintenance interval for air filters, due to the wide range of site conditions. It is up to the site maintenance staff to develop a cleaning and replacement schedule.

37. Air housings are generally marked with the part/model number of the filter, and contact information for reordering.

38. An inlet differential wc (water column) pressure gauge measuring differential pressure (each side of the filter) can provide a simple way to determine when filters are dirty.

39. Inspection Items:
   a. Ensure air filters are clean.
   b. Check piping, valves and diffusers for restrictions
   c. Ensure the oil reservoir is not overfilled
   d. Tighten and/or apply thread sealant to all drain plugs and fittings
   e. Replace any leaking gaskets, but do not use RTV or caulk to seal an oil leak
   f. If constant level oilers are present, look for faulty o-rings or improper adjustment
   g. Look for heavy foam in the sight glasses.
   h. Check for low air flow, including excessive backpressure from downstream valving
   i. Use proper lubricants.
   j. Check for failing bearings.

**Electrical Devices and Concepts**

Explain

1. Voltage (EMF)
2. Current (Amps)
3. Resistance (Ohm)
4. Direct Current (DC)
5. Alternating Current (AC)
6. Frequency (60 hertz) (1 cycle = 1/60 Hz = .0167 milliseconds)
7. Ohm’s Law (EMF=Amps x Ohms) or (V = I x R)
8. Watt (W = V x I)
9. Horsepower (1 hp = 746 watts)
10. Output HP = (P watts x Power Factor x Efficiency / 746 watts)
11. Power requirements (kilowatt hours) (kW = kW for 1,000 hours)
12. Single Phase AC
13. Three Phase AC
14. Bounding / Grounding
15. Delta AC Service
16. Wye AC Service
17. Voltage Tester
18. Voltmeters
19. Ohmmeters
20. Ammeters
21. Multimeters (VOM)
22. Wattmeters
23. Meggers
24. Conductors (selecting correct wire size)
25. Insulators (voltage rating)
26. GFCI protection circuits
27. Load Demand
28. Motor overloads (heaters)
29. Breakers
30. Disconnects
31. Fuses
32. Internal motor heating coils
33. Leak detection
34. Phase protection
35. Vibration monitoring
36. Grounding
37. Grounded
38. Motor and supervisory control system electrical components

Questions
1. What are two types of voltage?
2. What should you consider when selecting wire size?
3. How can you determine the proper voltage and allowable current in amps for a piece of equipment?
4. Should you be qualified and authorized before repairing or troubleshooting electrical circuits or equipment?
5. What should you consider before measuring voltage?
6. How can you determine if there is voltage in a circuit?
7. What should you check before applying an Ohm meter or megger to electrical equipment or circuits?
8. What should you turn off before using a megger?
9. What precautions should be taken before attempting to change fuses?
10. What could be the cause of amp readings different from the nameplate rating?
11. How do you test for voltage with a voltmeter when the voltage is unknown?
12. What are two types of safety devices found in main electrical panels or control units?
13. What are fuses used to protect?
14. Why must a fuse never be bypassed or jumped?
15. How does a circuit breaker work?
16. Should you energize electrical equipment with an unfused disconnect that may startup?
17. What should be done when a fuse or circuit breaker "blows" or trips?
18. Motor and supervisory control systems are composed of what types of auxiliary electrical equipment?
19. What are three basic factors that contribute to the reliable operation of electrical systems found in pump stations?
20. What can be measured with a multimeter?
21. What three measurements are commonly made with a VOM?
22. When measuring resistance with a VOM, what is the state of the power supply?
23. What is a clamp on amp meter primarily used to measure?
24. When measuring amperage of a motor, what is the state of the motor?
25. What is the intended purpose of internal motor heating coils?
26. What is the primary function of a GFCI device?
27. There are four common conditions that can cause severe damage to three phase motors. What are they and how can they be prevented?

28. What is the standard unit of measurement for resistance?

29. What reference should you use for proper wire sizing for electrical circuits, motors and services?

30. What is a watt hour meter and how is it used?

Instrumentation

1. Can you identify the following instruments?
   a. Air velocity (not in references)
   b. Chart recorder
   c. Chlorine
   d. Conductivity
   e. Dissolved oxygen (DO)
   f. Gas monitors
   g. Oxidation reduction potential (ORP)
   h. Particle counters (not in references)
   i. pH
   j. Power supply
   k. Recorders
   l. Streaming current (not in references)
   m. Temperature
   n. Totalizer
   o. Autodialers
   p. On/off control
   q. Programmable logic controllers (PLC)
   r. Radio/SCADA systems

2. Explain the following:
   a. Alarm set-points
   b. Analog
   c. Diaphragms
   d. Digital
   e. Oil fill (not in references)
   f. Programming
   g. Troubleshooting techniques

3. Can you identify the following Level/Flow Devices?
   a. Bubblers
   b. Conductivity
   c. Doppler
   d. Electrode
   e. Float
   f. Magnetic
   g. Manometer
   h. Palmer-Bowls flume
   i. Parshall flume
   j. Pressure differential (venturi)
   k. Pressure transducers
   l. Propeller
   m. Ultrasonic
4. Explain the proper application procedures for the Level/Flow measuring devices above?

5. How can you use drawdown methods to calibrate or confirm the proper operation of Level/Flow measuring devices?

6. What troubleshooting techniques would you use to check for proper operation of the Level/Flow measuring devices above?

**Math**

1. Addition and subtraction of whole numbers, decimals and proper and improper fractions.

2. Division and multiplication of whole numbers, decimals and proper and improper fractions.

3. Basic algebra.
   a. Solve for unknown based on given formulas.

4. Basic geometry.
   a. Area of the following shapes in square feet:
      i. Circles
      ii. Rectangles
      iii. Squares
      iv. Triangles
   b. Surface area of the following shapes:
      i. Cylinders (pipes given diameter and length)
      ii. Cones
      iii. Spheres
   c. Volume of the following shapes in both cubic feet and gallons:
      i. Square or rectangular tanks
      ii. Cylinders (Pipes – given diameter and length)
      iii. Spheres

5. Convert fractions to decimals and percentages and vice versa.
   a. Unit Conversion

6. Calculate with exponents.

7. Graphing:
   a. Interpret line, bar, percentage and broken-line graphs.
   b. Read corresponding y values based on given x values.

**Read information from tables.**

**Drawings**

1. Operations and maintenance manuals.
   a. Purpose
   b. Information found in manuals
   c. How to retrieve information from manual

2. System maps
   a. Kinds of system maps
   b. Purpose
   c. How to read

3. Geographic information system (GIS)
   a. Purpose
   b. How to read GIS maps.

4. Sketching techniques:
   a. Plan view
   b. Section view
   c. Isometric view

5. Standard operation procedures
6. Graphing
   a. How to graph based on given x and y values
   b. How to interpret graphs

Maintenance Management

1. The components of an infrastructure maintenance program
   a. REQUIRED ADMINISTRATIVE/MAINTENANCE MANAGEMENT
      i. Predictive Maintenance
      ii. Preventive Maintenance
      iii. Record Keeping
      iv. Work Order
   b. REQUIRED KNOWLEDGE OF ADMINISTRATIVE/MAINTENANCE MANAGEMENT
      i. Computer Maintenance Management Systems
      ii. Reporting Requirements
      iii. Spreadsheet Software
      iv. Word Processing Software
   c. MAINTAIN SYSTEM SECURITY
      i. Fences
      ii. Lighting and Locks
      iii. Chemical Delivery
      iv. Surveillance
   d. PROTECT SYSTEM SECURITY
      i. Data Security
      ii. Vehicle Security
   e. RESTRICT SYSTEM SECURITY
      i. Computer Access
      ii. System Access
   f. REQUIRED KNOWLEDGE OF SYSTEM SECURITY
      i. Communication Systems
      ii. Homeland Security
      iii. Security Awareness
   g. REQUIRED REGULATIONS AND STANDARDS
      i. Comply with Requirements
      ii. Implement Requirements
      iii. Record Requirements
      iv. Report Requirements
   h. REQUIRED KNOWLEDGE OF REGULATIONS AND STANDARDS
      i. CHEMTREC
      ii. Department of Homeland Security
      iii. Department of Transportation
      iv. Environmental Protection Agency 40 CFR
      v. National Incident Management System
      vi. National Sanitation Foundation
      vii. Occupational Safety & Health Administration
      viii. Office of Hazardous Materials Safety
      ix. State/Provincial Regulations

2. Explain why it is so important to have a preventive maintenance program at your facility.

3. Who provides mechanical maintenance information for your equipment?

4. Why are preventive maintenance records important to keep? How long should you keep them?

5. Why is it important to have accurate records.
6. What is a work order? Why are they important.

7. There are many types of computer managed maintenance software available. Why would they be effective in maintenance management?

8. Be able to use simple spreadsheet software (lotus, excel, some access database).

9. Know why it is important to have good records from NCDENR, EPA & OSHA perspective.

10. Name two reasons why your facility needs security fencing.

11. Understand why proper lighting is important throughout the facility.

12. Why should you have policies and procedures on chemical deliveries?

13. Why should a manufacturer/vendor supply you with a MSDS for every product delivered to your site?

14. Know the importance of the following:
   a. cameras, surveillance
   b. security of data and records
   c. security of vehicles
   d. logo on and security of computer use
   e. what makes your facility vulnerable

15. What is a vulnerability assessment? Why should one be completed in water and wastewater plants?

16. What are some threats or risks that a facility could face?

17. Why are emergency response plans important?

18. What does homeland security mean to you?

19. What is NIMS (National Incident Management System)?

20. Why is it important to have written communication plans?


22. List important aspects of maintaining operations and maintenance manuals.

23. What are S.O.P.’s? Why are they important in facility maintenance. List a few SOP’s.

24. Briefly understand how to read maps and diagrams within the plants.

25. What is GIS? How can GIS help in maintaining your facility?

26. Know how to perform basic graphing techniques and be able to interpret the following:
   a. bar graph
   b. bar charts
   c. line charts
   d. x.y coordinates
   e. Why are they useful?

27. Why is contingency planning necessary? Lists of phone numbers for maintenance personnel should be posted for emergency use. Know why the following are important:
   a. plant supervisor
   b. Public Works Director
   c. Police
   d. Fire
   e. Ambulance
   f. Hospital
   g. chlorine supplier
   h. Chemtrec
   i. DWQ
   j. EPA
   k. Poison Control Center


29. What is the purpose of EPA, who do they govern? WW SAC Chapter 20

30. Have knowledge of the following:
   a. NIMS
   b. National Sanitation Foundation
### Formula / Conversion Table

- **Amps** = \( \frac{\text{Volts}}{\text{Ohms}} \)

- **Area of Circle** = \((0.785) (\text{Diameter}^2)\) or \((\pi) (\text{Radius}^2)\)

- **Area of Cone (lateral area)** = \((\pi) (\text{Radius}) \sqrt{\text{Radius}^2 + \text{Height}^2}\)

- **Area of Cone (total surface area)** = \((\pi) (\text{Radius}) (\text{Radius} + \sqrt{\text{Radius}^2 + \text{Height}^2})\)

- **Area of Cylinder (total outside surface area)** = \([\text{Surface Area of End #1}] + [\text{Surface Area of End #2}] + [(\pi) (\text{Diameter}) (\text{Height or Depth})]\)

- **Area of Rectangle** = \((\text{Length}) (\text{Width})\)

- **Area of a Right Triangle** = \(\frac{(\text{Base})(\text{Height})}{2}\)

- **Average (arithmetic mean)** = \(\frac{\text{Sum of All Terms}}{\text{Number of Terms}}\)

- **Circumference of Circle** = \((\pi) (\text{Diameter})\)

- **Degrees Celsius** = \((\text{Degrees Fahrenheit} - 32) \left(\frac{5}{9}\right)\) or \(\left(\frac{\text{F} - 32}{1.8}\right)\)

- **Degrees Fahrenheit** = \([\text{Degrees Celsius}] \left(\frac{9}{5}\right) + 32\) or \([\text{Degrees Celsius}] (1.8) + 32\)

- **Electromotive Force (E.M.F), volts** = \((\text{Current, amps}) (\text{Resistance, ohms})\) or \(E = IR\)

- **Filter Backwash Rate, gpm/sq ft** = \(\frac{\text{Flow, gpm}}{\text{Filter Area, sq ft}}\)

- **Flow Rate, cfs** = \((\text{Area, sq ft}) (\text{Velocity, ft/sec})\) or \(Q = AV\) where: \(Q = \text{flow rate}, A = \text{area}, V = \text{velocity}\)

- **Force, pounds** = \((\text{Pressure, psi}) (\text{Area, sq in})\)

- **Horsepower, Brake (bhp)** = \(\frac{\text{Flow, gpm} (\text{Head, ft})}{(3,960) (\text{Decimal Pump Efficiency})}\)

- **Horsepower, Motor (mhp)** = \(\frac{\text{Flow, gpm} (\text{Head, ft})}{(3,960) (\text{Decimal Pump Efficiency}) (\text{Decimal Motor Efficiency})}\)

- **Horsepower, Water (whp)** = \(\frac{\text{Flow, gpm} (\text{Head, ft})}{3,960}\)
Leakage, gpd = \frac{\text{Volume, gallons}}{\text{Time, days}}

\text{Reduction in Flow, } % = \frac{(\text{Original Flow} - \text{Reduced Flow}) \times 100\%}{\text{Original Flow}}

\text{Slope, } % = \frac{\text{Drop or Rise}}{\text{Distance}} \times 100

\text{Specific Gravity} = \frac{\text{Specific Weight of Substance, lbs/gal}}{\text{Specific Weight of Water, lbs/gal}}

\text{Velocity, } \text{ft/sec} = \frac{\text{Flow Rate, cu ft/sec}}{\text{Area, sq ft}} \text{ or } \frac{\text{Distance, ft}}{\text{Time, sec}}

\text{Volume of Cone} = \frac{1}{3} \times 0.785 \times (\text{Diameter}^2) \times \text{Height}

\text{Volume of Cylinder} = 0.785 \times (\text{Diameter}^2) \times \text{Height}

\text{Volume of Rectangular Tank} = \text{Length} \times \text{Width} \times \text{Height}

\text{Watts (DC circuit)} = \text{Volts} \times \text{Amps}

\text{Watts (AC circuit)} = \text{Volts} \times \text{Amps} \times \text{Power Factor}

\text{Wire-to-Water Efficiency, } % = \frac{\text{Water Horsepower, HP}}{\text{Power Input, HP or Motor HP}} \times 100

\text{Wire-to-Water Efficiency, } % = \frac{(\text{Flow, gpm}) \times (\text{Total Dynamic Head, ft}) \times (0.746 \text{ kw/hp}) \times (100)}{\text{(3,960)} \times \text{(Electrical Demand, kilowatts)}}

\text{Conversion Factors:}

1 \text{ acre} = 43,560 \text{ square feet}
1 \text{ acre foot} = 326,000 \text{ gallons}
1 \text{ cubic foot} = 7.48 \text{ gallons}
1 \text{ cubic foot} = 62.4 \text{ pounds}
1 \text{ cubic foot per second} = 0.646 \text{ MGD}
1 \text{ foot} = 0.305 \text{ meters}
1 \text{ foot of water} = 0.433 \text{ psi}
1 \text{ gallon} = 3.79 \text{ liters}
1 \text{ gallon} = 8.34 \text{ pounds}
1 \text{ grain per gallon} = 17.1 \text{ mg/L}
1 \text{ horsepower} = 0.746 \text{ kW} \text{ or } 746 \text{ watts} \text{ or } 33,000 \text{ ft. lbs./min.}
1 \text{ million gallons per day} = 694 \text{ gallons per minute}
1 \text{ million gallons per day} = 1.55 \text{ cubic feet per second}
1 \text{ mile} = 5,280 \text{ feet}
1 \text{ pound} = 0.454 \text{ kilograms}
1 \text{ pound per square inch} = 2.31 \text{ feet of water}
1 ton = 2,000 pounds
1% = 10,000 mg/L
Π or pi = 3.14

Abbreviations:
cfs cubic feet per second
ft feet
g grams
gpd gallons per day
gpg grains per gallon
gpm gallons per minute
in inches
kW kilowatt
lbs pounds
mg/L milligrams per liter
MGD million gallons per day
mL milliliter
psi pounds per square inch
Q flow