WATER DISTRIBUTION
STUDY GUIDE
GRADES 1 & 2

CONTENTS

CHAPTER 1
USEPA DRINKING WATER REGUALTIONS

MAXIMUM CONTAMINANT LEVEL (MCL) – the maximum permissible level of the contaminant in water as specified in the regulations of the safe drinking water act.

TIME COMPOSITE SAMPLE – a composite sample consisting of several equal volume samples taken at specified times.

FLOW PROPORTIONAL COMPOSITE SAMPLE – a composite sample in which individual samples volumes are proportional to the flow rate at the time of sampling.

WATCH THE VIDEO
Sampling Techniques
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=2siRtgMA3Ss


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MAXIMUM CONTAMINANT LEVEL GOAL (MCLG) – non-enforceable health base goals published along with the promulgation of an MCL. Originally called recommended maximum contaminant levels (RMCLs).

WATCH THE VIDEO
Disinfection By-products
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=Na85n3ObZkk


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STUDY QUESTIONS

1. Which agency sets legal limits on the concentration levels of harmful contaminants in potable Water distributed to customers?
    a. National Primary Drinking Water Regulations Agency
    b. US Environmental Protection Agency
    c. US Public Health Service
    d. Occupational Health and Safety Administration

2. The number of monthly distribution system bacteriological samples required is

a. based on the water withdrawal permit limit.
b. based on system size.
c. based on population served.
d. different for each state.

3. What is the maximum contaminant level for total trihalomethanes (TTHM) in the United States?
a. 0.040 mg/L
b. 0.060 mg/L
c. 0.080 mg/L
d. 0.100 mg/L

4. Under the Surface Water Treatment Rule, disinfection residuals must be collected at the same location in the distribution system as
a. coliform samples.
b. total trihalomethanes.
c. disinfection by-products.
d. alkalinity, conductivity, and pH for corrosion studies.

5. Iron can cause "red water" and thus customer complaints when its concentration is above its secondary maximum contaminant level of
a. 0.01 mg/L.
b. 0.05 mg/L.
c. 0.10 mg/L.
d. 0.30 mg/L.

6. The goal of the Surface Drinking Water Act is for each_____to accept primary enforcement responsibility (primacy) for the operation of the state's drinking water program.
a. state
b. water treatment plant
c. operator
d. municipality

7. What is the objective of the Total Coliform Rule?
a. To provide Cryptosporidium protection in new facilities
b. To ensure safe levels of lead and copper in drinking water
c. To protect the public from exposure to Giardia lamblia and Cryptosporidium
d. To promote routine surveillance of distribution system water quality to search for fecal matter and/or disease-causing bacteria.

8. Which agency sets standards on the concentration levels of harmful contaminants in drinking water?
US Environmental Protection Agency

9. Explain the difference between the different tiers of violations. Which one is the most serious?
Tier 1 is an acute MCL violation requiring public notification within 24 hours. Tier 2 notification must occur within 30 days. Tier 3 requires notification within 1 year.

10. A positive E. coli test must be reported to the primacy health agency within what time period?

24 hours

11. How is the required number of monthly bacteriological samples determined?
    Population Served

12. What is the action level for lead in first-draw samples taken from customer taps?
    0.0015 mg/l

13. A water system is designated a community public water system if it serves how many homes?
    15 or more

14. What authority provides specific water sampling instructions?
    The state primacy agency

15. According to the Lead and Copper Rule, what is the action level for lead?
    0.0015 mg/l

CHAPTER 2

OPERATOR MATH

WATCH THE VIDEO
Volume Measurements
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=_jAggVXUDsM

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AVERAGE DAILY FLOW (ADF) – a measurement of the amount of water treated by a plant each day. It is the average of the actual daily flows that occur within a period of time, such as a week, a month, or year. Mathematically, it is the sum of all daily flows divided by the total number of daily flows used.

WATCH THE VIDEO
Calculating Head
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=I2k9mUZD08Y

WSO Water Distribution Grades

STUDY QUESTIONS

1. Determine the detention time in hours for the following water treatment system:
- Distribution pipe from water plant to storage tank is 549 ft in length and 14 in. in diameter
- Storage tank averages 2,310,000 gal of water at any given time
- Flow through system is 6.72 mgd

a. 7.2 hr
b. 7.4 hr
c. 8.0 hr
d. 8.3 hr

First, convert pipe diameter from inches to feet:
Pipe diameter, ft = (14 in.)(l ft/12 in.) = 1.167 ft

Next, find the number of gallons in the pipeline:
Number of gal = (0.785)(diameter, ft)^2(length, ft)(7.48 gal/ft^3)
Number of gal = (0.785)(1.167 ft)(1.167 ft)(549 ft)(7.48 gal/ft^3) = 4,390 gal

Add the pipe and tank volume together to get the total number of gallons:
Pipe and tank volume, gal = 4,390 gal + 2,310,000 gal = 2,314,390 gal

Then convert mgd to gallons per day:
Number of gal = (6.72 mgd)(1,000,000) = 6,720,000 gal/day

Using the following equation, solve for the detention time:

$$\text{Detention time, hr} = \frac{\text{(Total volume)(24 hr/day)}}{\text{Flow, gal/day}}$$

Flow, gal/day

Substitute known values and solve:

$$\frac{\text{(2,314,390 gal)(24 hr/day)}}{\text{6,720,000 gal/day}} = \textbf{8.266 hr, round to 8.3 hr}$$

2. If chlorine is being fed at a rate of 260 lb/day for a flow rate of 23 cfs, what should be the adjustment on the chlorinator when the flow rate is decreased to 16 cfs, if all other water parameters remain the same?

a. 160 lb/day
b. 180 lb/day
c. 310 lb/day
d. 370 lb/day

(260 lb/day) x (16 cfs) = 4,160

$$\frac{\text{4,160}}{\text{23 cfs}} = \textbf{180.869}$$

3. How many gallons of a sodium hypochlorite solution that contains 12.1% available chlorine are needed to disinfect a 1.5-ft diameter pipeline that is 283 ft long, if the dosage required is 50.0 mg/L? Assume the sodium hypochlorite is 9.92 lb/gal.

a. 0.87 gal sodium hypochlorite
b. 1.0 gal sodium hypochlorite
c. 1.3 gal sodium hypochlorite
d. 1.5 gal sodium hypochlorite

First, find the volume of the pipe:
Volume, gal = (0.785)(diameter, ft)^2 (length, ft)(7.48 gal/ft^3)
0.785 x 1.5 x 1.5 x 283 x 7.48 = 3,739 gal

Next, find the number of million gallons (mil gal):
3,739 / 1,000,000 = 0.003739 mgd

Use "pound" equation

$$\textbf{Sodium hypo solution, lb} = \frac{\textbf{0.003739 (mgd) x 50.0 (mg/L) x 8.34 (lb/gal)}}{\textbf{12.1\% (avail chlorine) / 100\%}} = \textbf{12.89}$$

Lastly, calculate the number of gallons of sodium hypochlorite:

Sodium hypochlorite, gal = 12.89 1b + 9.92 lb/gal = 1.299 gal, rounded to 1.3 gal

4. A storage tank has a 60.0-ft radius and averages 25.5 ft in water depth. Calculate the average detention time in hours for this storage tank, if flow through the tank averages 2.91 mgd during the month in question.

a. 17.5 hr
b. 17.8 hr
c. 18.6 hr
d. 19.8 hr

First, find the diameter:
Diameter, ft = 2(radius) = 2(60.0 ft) = 120 ft
Then, determine the volume of water in the storage tank:
Volume, gal = (0.785)(diameter, ft)^2(depth, ft)(7.48 gal/ft^3)
.785 x 120 x 120 x 25.5 x 7.48 = 2,156,125 mgd

Next, convert mgd to gallons per day:
Flow through the tank, gal/day = 2.91 mgd x 1,000,000 = 2,910,000 gal/day

Next solve for the detention:
Detention time, hr = [(tank volume x 24 hr/day)] / flow, gal/day

$$\text{2,156,125 gal x 24} = \frac{\text{51,747,000}}{\text{2,910,000 gal/day}} = \text{17.78}$$

5. A 24.0-in. pipeline, 427 ft long, was disinfected with calcium hypochlorite tablets with 65.0% available chlorine. Determine the chlorine dosage in mg/L, if 7.0 1b of calcium hypochlorite was used. Assume that the hypochlorite is so diluted that it weighs 8.34 lb/gal.

a. 25 mg/L chlorine
b. 39 mg/L chlorine
c. 43 mg/L chlorine
d. 54 mg/L chlorine

First, convert the diameter of the pipeline from inches to feet:
Number of feet = 24.0 in. + 12 in./ft = 2.0 ft

Next, find the number of gallons by determining the volume of the pipeline:
Volume of pipe, gal = (0.785)(diameter, ft)2(length, ft)
.785 x 2 x 2 427 x 7.48 = 10,029 gal

Convert to mgd
10,029 / 1,000,000 = 0.010029

Calculate the dosage by rearranging the "pounds" equation

$$\text{Calcium hypochlorite, lb/day} = \frac{\text{mgd)(Dosage, mg/L)(8.34 lb/gal)(100\%)}}{\text{\% available chlorine}}$$

Rearrange the equation and drop the day on each side of the equation (not needed)

$$= \frac{\text{(calcium hypochlorite, 1b)(65.0\% available chlorine) Dosage, mg/L}}{\text{(mil gal)(8.34 lb/gal)(100\% calcium hypochlorite)}}$$

$$= \frac{(7.0)(65.0\%)}{(0.010029)(8.34)(100\%)}$$

= 54.4 mg/L, round to 54 mg/L

6. A well yields 2,840 gallons in exactly 20 minutes. What is the well yield in gpm?
   a. 140 gpm
   b. 142 gpm
   c. 145 gpm
   d. 150 gpm

Equation: well yield, gpm = $\dfrac{\textbf{Gallons produced}}{\textbf{Test duration, min}}$

$$\frac{\textbf{2,840 gal}}{\textbf{20 min}} = \textbf{142 gpm}$$

7. What is the area of a circular tank pad in ft^2, if it has a diameter of 102 ft?
   a. 6,160 ft^2
   b. 6,167 ft^2
   c. 8,170 ft^2
   d. 8,200 ft^2

Equation: Area = Ttr^2, where Tt = 3.14

First find the radius: Radius = diameter/2 = 102/2 = 51 ft
Area of tank = (3.14)(51 ft)(51 ft) = 8,167.14 ft^2, rounded to 8,170 ft^2

8. What is the pressure at 1.85 feet from the bottom of a water storage tank if the water level is 28.7 feet?
   a. 11.6 psi
   b. 12.4 psi
   c. 62.0 psi
   d. 66.3 psi

Equation: substract water level from the level in question, 1.85 feet.

Numbefr of feet in question = 28.7 ft – 1.85 ft = 26.85 ft

Pressure, psi = 26.85 ft x .433 psi ft = 11.626

9. How many gallons are in a pipe that is 18.0 inches in diameter and 1,165 feet long?
   a. 2,060 gal
   b. 10,300 gal
   c. 15,400 gal
   d. 17,200 gal

First convert the diameter from inches to feet:

$$\text{Number of feet} = \frac{18.0 \text{ in.}}{12 \text{ in./ft}} = 1.50 \text{ ft}$$

Next, calculate the volume:
Pipe volume, gal = (0.785)(diameter, ft)^2 (length, ft)(7.48 gal/ft^3)
.785 x 1.5 x 1.5 x 1,165 x 7.48 = 15,391 gal rounded up to 15,400

10. Convert 37.4 degrees Fahrenheit to degrees Celsius.
    a. 3.0 ^{O}C
    b. 5.3 ^{0}C
    c. 7.9 ^{0}C
    d. 9.7 C

Equation: ^{o}C = (^{O}F - 32) X 5/9

First: 37.4 - 32 = 5.4

Then: 5.4 x 5 = 270 / 9 = 3.0 ^{o}c

11. If 288 is 70.3%, how much is 100%?
    a. 410
    b. 412
    c. 415
    d. 418

$$\text{Equation: 100\% number} = \frac{\text{(number given)(100\%)}}{\text{percent of given number}}$$

$$\frac{288}{70.3\%} = 4.0967\ (100\%) = 409.6$$

12. What resource allows you to convert units, such as feet to inches, simply by following the instructions indicated in the table headings?
    Conversion table

13. How many gallons are in a cubic foot?
    7.48

14. If the water level rises by 15 feet, how many yards has it risen?
    5

15. What is the formula for calculating average daily flow?

ADF = Sum of all daily Flows .
Total number of daily flows used

16. How do you convert deciliters to milliliters?
Multiply by 100, or move the decimal two places to the right

CHAPTER 3
WATER USE AND SYSTEM DESIGN

RIPARIAN DOCTRINE – a water right that allows the owner of the land abutting a stream or other natural body of water to use the water.

PRIOR APPROPRIATION DOCTRINE – A water rights doctrine in which the first user has a right to water before subsequent users.

PRIORITY IN TIME – the assessing of water rights based on who has been using the water the longest.

BENEFICIAL USE – a water rights term indicating that the water is being used for good purposes.

ABSOLUTE OWNERSHIP – a water rights term referring to water that is completely owned by one person.

REASONABLE USE – the water rights term indicating that the water use is acceptable in general terms.

OVERLYING USE – the land use that occurs on top of an aquifer.

CORRELATIVE RIGHTS – the rule that contends that the overlying use rule is not absolute but is related to the rights of other overlying users. This rule is used when there's not enough water to satisfy all overlying uses.

SURFACE WATER SYSTEM – a water system using water from a lake or stream for its supply.

GROUNDWATER SYSTEM – a water system using wells, springs, or infiltration galleries as its source of supply.

PURCHASE WATER SYSTEM – a water system that purchases water from another water system and so generally provides only distribution and minimal treatment.

ARTERIAL LOOP SYSTEM – a distribution system layout involving a complete loop of arterial mains sometimes called trump mains or feeders around the area being served, with branch mains projecting inward. Such a system minimizes dead ends.

GRID SYSTEM – a distribution system layout in which all ends of the main are connected to eliminate dead ends.

TREE SYSTEM – a distribution system layout that centers around a single arterial Main, which decreases in size with length. Branches are taken off at right angles, with subbranches from each branch.

HAZEN-WILLIAMS FORMULA – a formula for the velocity of flow in a pipe.

STUDY QUESTIONS

1. Head is measured in
    a. absolute pressure.
    b. gauge pressure.
    c. feet.
    d. foot-pounds.

2. A plat is
    a. a map.
    b. a corrosion point on a pipe.
    c. an organelle found in some protozoans.
    d. a highly corrosive soil type.

3. At which time of day is the age of the water stored in the distribution system the highest?
    a. Early morning
    b. Late morning
    c. Early afternoon
    d. Late evening

4. Water mains should primarily be sized based on
    a. earthquake size potential.
    b. peak domestic and commercial demands.
    c. peak commercial and industrial demands.
    d. adequate fire flow at an appropriate pressure.

5. The most desirable residential pressure ranges from
    a. 20 to 35 psi (138 to 241 kPa).
    b. 35 to 50 psi (241 to 345 kPa).
    c. 50 to 75 psi (345 to 517 kPa).
    d. 75 to 90 psi (517 to 621 kPa).

6. Domestic water use includes water that is supplied to residential areas,_____, and institutional facilities.
    a. public parks
    b. commercial districts
    c. industrial facilities
    d. municipal buildings

7. Riparian doctrine is sometimes called the "rule of
    a. first come, first serve."
    b. reasonable sharing.
    c. equal use."
    d. eminent domain."

8. During which season is water use typically the highest?

Summer

9. Of the common types of distribution systems, which type is considered least desirable?

Tree system

10. What type of valves should be provided so that areas within the system can be isolated for repair or maintenance?

Shutoff valves

CHAPTER 4
HYDRAULICS

HYDRAULICS – the study of fluids in motion or under pressure.

PRESSURE - the force on a unit area of water.

STATIC PRESSURE – pressure that exist in water although the water does not flow.

DYNAMIC PRESSURE – pressure that exist in water as moving energy.

POUNDS PER SQUARE INCH PSI – a measure of pressure.

HYDROSTATIC PRESSURE – the pressure exerted by water at rest for example, in a non-flowing pipeline.

VELOCITY – the speed at which water moves; measured in ft/sec or m/sec.

HEAD – (1) a measure of the energy possessed by water at a given location in the water system, expressed in feet. (2) a measure of the pressure or force exerted by water, expressed in feet.

GAUGE PRESSURE – the water pressure as measured by a gauge. Gauge pressure is not the total pressure. Total water pressure (absolute pressure) also includes the atmospheric pressure (about 14.7 psi) at sea level exerted on the water. However, because atmospheric pressure is exerted everywhere against the outside of the main as well as the inside for example, it is generally not written into water system calculations. Gauge pressure is in pounds per square inch is expressed as PSIG.

POUNDS PER SQUARE INCH GAUGE PSIG – pressure measured by a gauge and expressed in terms of pounds per square inch.

ABSOLUTE PRESSURE – the total pressure in the system, including both the pressure of water and the pressure of the atmosphere about 14.7 PSI, at sea level.

PRESSURE HEAD – the pressure of the amount of energy and water due to water pressure.

HYDRAULIC GRADE LINE HGL – a line (hydraulic profile) indicating piezometric level of water at all points along a conduit, open channel, or stream. In an open channel, the HGL is the free water surface.

ELEVATION HEAD – the energy possessed per unit weight of the fluid because of its elevation above some reference point (called referenced datum). Elevation head is also called position head or potential head.

VELOCITY HEAD – a measurement of the amount of energy in water due to its velocity, or motion.

WATCH THE VIDEO
Operator Chemistry
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=Ay5l2bkcY7Y

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ENERGY GRADE LINE EGL – a line joining the elevations of the energy heads; a line drawn above the hydraulic grade line by a distance equivalent to the velocity head of the flowing water at each section along a stream, channel, or conduit.

STUDY QUESTIONS

1. Head is measured in
   a. absolute pressure.
   b. gauge pressure.
   c. feet.
   d. foot-pounds.

2. If the pressure head on a fire hydrant is 134 ft, what is the pressure in psi?
   a. 50 psi
   b. 52 psi
   c. 54 psi
   d. 58 psi

   Equation: Pressure head, ft = (Pressure, psi)(2.31 ft/psi) Rearrange to solve for pressure in psi:

   Pressure, psi = (Pressure head, ft) + (2.31 ft/psi)

   Pressure, psi = 134 ft 2.31 ft/psi = 58 psi

3. A meter indicates the water flow from a fire hydrant is 5.5 ft^3/min. How many gallons will flow from the hydrant in 20 minutes?
   a. 820 gal
   b. 850 gal
   c. 880 gal
   d. 920 gal

First, convert the flow in ft^3/min to gallons per minute (gpm):

gpm = (5.5 ft^3/min)(7.48 gal/ft^3) = 41.14 gpm

Then determine the number of gallons that flowed through the fire hydrant:

Gallons = (41.14 gpm)(20 min) = 822.8 gal, rounded to 820 gal

4. Records for a pump show that on June 1 at exactly 9:00 a.m. the number of pumped gallons was 71,576,344 and on July 1 at exactly 9:00 a.m. it was 72,487,008 gallons. Determine the average gallons pumped per day (gal/day) for this month to the nearest gallon.

a. 18,605 gal/day
b. 25,875 gal/day
c. 30,355 gal/day
d. 34,325 gal/day

72,487,008 – 71,576,344 = 910,664 (total gallons pumped from June 1 to July 1)
910,644 / 30 (days) = 30,355 gal/day

5. The velocity of water is calculated as the quantity of water that flows through a pipe

a. divided by the cross-sectional area of the pipe.
b. divided by the time the water takes to reach its destination.
c. divided by the water's weight in cubic feet.
d. multiplied by resistance to flow.

6. What is the term for water pressure in a main or in a container that is measured by a gauge?

Gauge pressure

7. In hydraulics, how is head expressed?

$$\textbf{head} = \frac{\textbf{ft-lb}}{\textbf{1b}}$$

8. What is the term for pressure measured in terms of the height of water (in meters or feet)?

Head

9. What are the three types of head?

Elevation head, velocity head, and pressure head

CHAPTER 5
PIPE

EXTERNAL LOAD – any load placed on the outside of the pipe from backfill, traffic, or other sources.

INTERNAL PRESSURE – the hydrostatic pressure within a pipe.

WATER HAMMER – the potentially damaging slam, bang, or shutter that occurs in a pipe when a sudden change and water velocity usually as a result of someone too rapidly starting a pump or operating a valve creates a great increase in water pressure.

TENSILE STRENGTH – a measure of the ability of pipe or other material to resist breakage when is polled lengthwise.

FLEXURAL STRENGTH – the ability of the material to bend flex without breaking.

TUBERCULATION – the growth of nodules to tubercles on the pipe interior, which reduces the inside diameter and increases the pipe roughness.

TRANSMISSION LINE – the pipeline or aqueduct used for water transmission, i.e., movement of water from the source to the treatment plant and from the plant to the distribution system.

IN PLANT PIPING SYSTEM – the network of pipes in a particular facility, such as a water treatment plant, that carry the water or waste for that facility.

DISTRIBUTION MAIN – in a pipe in the distribution system other than the service line.

SERVICE LINE – the pipe (and all appurtenances) that runs between the utilities water main and the customers place of use, including fire lines.

WATCH THE VIDEO
Ductile-Iron Pipe
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=KPggP4LAgXw

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FLANGED JOINT – a pipe joints that consist of two machined surfaces that are tightly bolted together with a gasket between them.

MECHANICAL JOINT – a pipe joint for ductile iron pipe that uses bolts flanges and a special gasket.

BALL AND SOCKET JOINT – a special purpose pipe joint that provides for a large deflection up to 15 degrees and is positively connected so it won't come apart.

PUSH ON JOINT – a pipe joint consisting of a bell with a specifically designed recess to accept a rubber ring gasket. The spigot end must have a beveled edge, so it will slip into the gasket without catching or tearing it.

WATCH THE VIDEO
Steel pipe
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=cfxJp4F5dxs


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PERMEATION – the process by which organic compounds passed through plastic pipe.

WATCH THE VIDEO
PVC pipe
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=KumLHPhAsEQ


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WATCH THE VIDEO
PE pipe
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=NWWvTsImsdU


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PRESTRESSED CONCRETE – reinforced concrete placed in compression by highly stressed, closely spaced, helically wound wire. The pre-stressing permits the concrete to withstand tension forces.

WATCH THE VIDEO
Concrete pipe
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=kSim5UAzG-w


WSO Water Distribution Grades

STUDY QUESTIONS

1. The highest degree of protection for the exterior of a coated steel pipe is
   a. cathodic protection.
   b. bituminous materials.
   c. plastic coatings.
   d. polyethylene tapes.

2. The C value is a measure of a pipe wall's
   a. smoothness.
   b. smoothness, which allows even flow.
   c. smoothness, which retards turbulent flow.
   d. roughness, which retards flow due to friction.

3. Which of the following is a type of joint for ductile iron piping?
   a. Expansion joint
   b. Push-on joint
   c. Bell and spigot with rubber O-ring
   d. Rubber gasket joint

4. What is the term for a sudden repeated increase and decrease in pressure that continues until dissipated by friction losses?
   a. Pipe knocking
   b. Water hammer
   c. Pipe shear
   d. Beam breakage

5. Which of the following is not a type of joint generally used today for connecting DIP and fittings?
   a. Push-on joint
   b. Flanged joint
   c. Riveted joint
   d. Mechanical joint

6. What measurement of a pipe's strength refers to its ability to withstand the pressure exerted on it after it has been buried in a trench?
External Load

7. What term refers to the process by which organic compounds pass through plastic pipe?
   Permeation

8. What type of cylinder pipe is manufactured by casting mild steel reinforcing cages and a steel cylinder with welded joint rings within a thick concrete core?
   Reinforced concrete cylinder pipe.

CHAPTER 6
WATER MAIN INSTALLATION AND REHABILITATION

WATCH THE VIDEO
Pipe Handling Safety for field crews
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=wUjXRBpnRaQ

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SLOPING – a method of preventing cave-in's that involves excavating the sides of the trench at an angle (the angle of repose) so that the sides will be stable.

SHIELDING – a method to protect workers against cave-in's through the use of a steel box opened at the top, bottom, and ends. Allows the workers to work inside the box while installing water mains.

SHORING – a framework of wood and/or metal constructed against the walls of the trench to prevent cave-in of the earth walls.

SHEETING – a method to protect workers against cave-in by installing tightly spaced upright planks against each other to form a solid bay area against the faces of the excavation.

WATCH THE VIDEO
Trenching and Shoring
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=X9osC_mPLRE

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COUPON – in tapping, the section of the main cut out by the drilling machine.

THRUST – 1. The force resulting from water under pressure and in motion. Thrust pushes against fittings, valves, and hydrants; it can cause couplings to leak or to pull apart entirely. 2. In general, any pushing force.

THRUST BLOCK – a mass of concrete cast in place between a fitting to be anchored against thrust and the undisturbed soil at the side or bottom of the pipe trench.

THRUST ANCHOR – a block of concrete, often a roughly shape cube, cast in place below a fitting to be anchored against vertical thrust, and tied to the fitting with anchor rods.

TIE ROD – the device frequently used to restrain mechanical joint fittings that are located close together when thrust blocks cannot be used.

RESTRAINING FITTING – a device for restraining joints that are particularly useful in locations where other existing utilities or structures are so numerous that the thrust blocks are precluded.

STUDY QUESTIONS

1. When PVC pipe is stacked loose, it should not be stacked more than how high?
    a. 2.0 feet
    b. 3.0 feet
    c. 5.0 feet
    d. 7.5 feet

2. What is the most common cause for pipe joint failure (leaking) in newly laid pipe?
    a. The use of a cracked gasket
    b. Not pushing the spigot end the full distance into the bell
    c. Not having the joint completely clean
    d. An incorrect trench bedding angle

3. The backfill material for a pipe installation should contain enough _____to allow for thorough compaction.
    a. moisture
    b. sand
    c. gravel
    d. mixed sizes

4. What is the approximate angle of repose for average soils when using the sloping method for the prevention of cave-ins? (Note: horizontal to vertical distance, respectively)
    a. 0.5:1.0
    b. 1.0:1.0
    c. 1.5:1.0
    d. 2.0:1.0

5. Which of the following statements is true regarding unloading gaskets?
    a. Always have gaskets as near the trench as possible for easy installation.
    b. Always store gaskets in a clean, secure location until they are needed.
    c. Store gaskets near electric motors or other operating electrical equipment.
    d. Don't worry about getting gaskets dirty while unloading, as long as they're cleaned before If installation.

6. Wherever a water main crosses a sewer line, the water main should be at least_____above or below the sewer line.
    a. 12 in. (0.3 m)
    b. 18 in. (0.45 m)
    c. 24 in. (0.61 m)
    d. 30 in. (0.76 m)

7. What form of pipe shipment is preferable from the user's standpoint because the pipe can usually be unloaded directly at the jobsite?

Truck delivery

8. What is the greatest expense relating to pipe installation?

Excavation

9. What is the term for the process of installing tightly spaced upright planks against each other to form a solid barrier against the faces of the excavation?

Sheeting

CHAPTER 7
BACKFILLING, MAIN TESTING, AND INSTALLATION SAFETY

BACKFILL – 1. the operation of refilling an excavation, such as a trench, after the pipeline or other structure has been placed into the excavation. 2. The material used to fill the excavation in the process of backfilling.

CONTINUOUS FEED METHOD – a method of disinfecting new or repaired mains in which chlorine is continuously added to the water being used to fill the pipe, so that a constant concentration can be maintained.

SLUG METHOD – a method of disinfecting new or repaired water mains in which a high dosage of chlorine is added to a portion of the water use to fill the pipe. This slug of water is allowed to pass through the entire length of pipe being disinfected.

TABLET METHOD – a method of disinfecting new or repaired water mains in which calcium hypochlorite tablets are placed in a section of pipe. As the water fills the pipe, the tablets dissolved, producing a chlorine concentration in the water.

WATCH THE VIDEO
Water Main Disinfection and De-chlorination
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=g-T7TRpcUmY

WSO Water Distribution Grades

WATCH THE VIDEO
Traffic Zone Safety
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=S9Fo-DNIID0

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STUDY QUESTIONS

1. If an excavation on a road requires that one of the lanes be closed and the speed limit is 25 mph (40 kph), how many cones are required to divert the traffic?

a. 6
b. 9
c. 13
d. 15

2. Which of the following is not generally a process used for compacting the pipe embedment and backfill placed in a trench?

a. Tamping
b. Vibrating
c. Saturating with water
d. Sifting

3. Leakage is defined as the volume of water that must be added to the full pipeline to maintain a specified test pressure within a_____range.

a. 10-psi (69-kPa)
b. 5-psi (34-kPa)
c. 3-psi (21-kPa)
d. 12-psi (83-kPa)

4. Which of the following is not one of the commonly used methods of applying disinfectant?

a. Stream method
b. Slug method
c. Tablet method
d. Continuous feed method

5. Under any soil conditions, cave-in protection is required for trenches or excavations_____deep or more.

a. 15 ft (4.6 m)
b. 10 ft (3.0 m)
c. 5 ft (1.5 m)
d. 2 ft (0.6 m)

6. When disinfecting a new pipeline with calcium hypochlorite tablets or granules, what should the chlorine target be?

25 mg/l

7. How deep should the compacted covering layer be for pipe less than 8 in. (200 mm) in diameter? For pipe larger than 8 in. (200 mm) in diameter?

6-12 inches (150-300 mm), 12-24 inches (300-610 mm)

8. How much leakage is allowed for a new pipeline test?

The amount given in AWWA standards and manuals.

9. How must a pipeline be prepared before a sample is taken for bacteriological testing?

The pipeline must be flushed of chlorinated water and refilled with water from the system.

10. What term refers to the process of repeatedly pushing a pressurized water pipe vertically to near the bottom of the loose fill at intervals along the excavation?

Jetting

CHAPTER 8
WATER SERVICES

METER BOX – a pit-like enclosure that protects water meters installed outside of buildings and allows access for reading the meter.

GALVANIC CORROSION – a form of localize corrosion caused by the connection of two different metals in an electrolyte such as water.

CORPORATIONS STOP – a valve for joining a service line to a street water main. Cannot be operated from the surface.

CURB STOP – a shutoff valve attached to a water service line from a water main to a customer's premises, usually place near the customers property line. It may be operated by a valve key to start or stop flow to the water supplied line.

CURB BOX – a cylinder placed around a curb stop and extending to the ground surface to allow access to the valve.

DRY TAP – a connection made to a main that is empty. Compare with wet tap.

WET TAP – a connection made to a main that is full or under pressure. Compare with dry tap.

TAPPING – the process of connecting laterals and service lines to mains and/or other laterals.

SERVICE SADDLE – a device attached around a main to hold the corporation stop. Used with main's that have thinner walls to prevent leakage.

WATCH THE VIDEO
Tapping concrete Pressure Pipe, Tapping Ductile-Iron Pipe,
Tapping PE Pipe, Tapping PVC Pipe, Tapping Steel Pipe
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=RJAnEN8g1LI

WSO Water Distribution Grades

STUDY QUESTIONS

1. A corporation stop is used for a
   - **a. service line.**
   - b. pump discharge line.
   - c. tank inlet.
   - d. tank outlet.

2. Compression fittings used with copper or plastic tubing seal by means of
   - a. a beveled sleeve.
   - b. a compression ring.
   - **c. a compressed beveled gasket.**
   - d. compressed O-rings located at either end of the fitting's beveled neck.

3. Water meter pits are usually used in
   - a. areas where flooding will most likely occur.
   - b. areas where flooding is very rare.
   - **c. cold climates.**
   - d. hot climates.

4. Which of the following is not an advantage of installing meters outside in boxes?
   - a. In areas where ground frost is nominal, a meter box can be relatively small, inexpensive, and easy to install.
   - b. If the boxes can always be readily located, meter boxes make meter reading easier because meter readers do not have to enter a building.
   - **c. In areas where there is deep frost, meter pits are much more expensive to construct.**
   - d. Placing meters outside eliminates the need to enter buildings to replace the meters, which is difficult in some inside locations.

5. Other utilities will allow installation of a meter in a crawl space or utility closet as long as (1) the meter can easily be accessed by a meter reader or (2)
   - **a. the meter is equipped with a remote reading device.**
   - b. the homeowner can easily access and report the meter readings.
   - c. the meter can self-report to the utility.
   - d. water fees in the area are fixed and readings are unnecessary.

6. What may cause galvanized iron pipe to corrode excessively?
   Direct connection to brass and other metal fittings

7. What is a curb stop used for?
   Turning off service for repair or as the result of non-payment.

8. What is the typical service line size for a single-family residence?
   ¾ inch (19 mm)

9. What is the term for the valve used to connect a small-diameter service line to a water main?
   Corporation stop

10. What is generally considered the best location for a tap on a main?
    At an angle of about 45 degrees down from the top of the pipe.

CHAPTER 9
VALVES

VALVE – a mechanical device installed in the pipeline to control the amount in direction of water flow.

ISOLATION – a installed a pipeline to shut off low in a portion of the pipe, for the purpose of inspection or repair, such bells are usually installed in the main lines.

PRESSURE REDUCING – a valve with a horizontal disc for automatically reducing water pressures in a Main to a preset value.

ALTITUDE VALVE – a valve that automatically shuts off water flow when the water level in an elevated tank reaches a preset elevation, then opens again when the pressure on the system side is less than that on the tank side.

PRESSURE RELIEF VALVE – a valve that opens automatically when the water pressure reaches a preset limit to relieve the stress on a pipeline.

AIR RELIEF VALVE – an air valve placed at a high point in a pipeline to release air automatically, thereby preventing air binding and pressure buildup.

WATCH THE VIDEO
Valves
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=b3b-iBz73Ww

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GATE VALVE – a valve in which the closing element consist of a disc that slides across an opening to stop the flow of water.

NON-RISING STEM VALVE – a gate valve in which the valve stem does not move up or down as it is rotated.

HORIZONTAL VALVE – a gate valve that is designed such that the valve operating mechanism does not have to lift the weight of the gate to open the valve.

BYPASS VALVE – a small valve installed in parallel with the larger valve. Use to equalize the pressure on both sides of the disc of the larger valve before and the larger valve is opened.

TAPPING VALVE – a special shutoff valve used with a tapping sleeve.

CUTTING IN VALVE – a specially designed gate valve used with a sleeve that allows the valve to be placed in an existing main.

INSERTING VALVE – A shut off valve that can be inserted by special apparatus into a pipeline while the line is in service under pressure.

RESILIENT SEATED VALVE – a gate valves with a disc that has a resilient material attached to it to allow leak tight shutoff at high pressure.

SLIDE VALVE – a gate valve that uses a relatively thin gate or blade that slides up and down in a recess to stop low pressure flows where tight shut off is not important.

GLOBE VALVE – a valve having a round, ball like shell and horizontal disc.

NEEDLE VALVE – a valve that is similar to a globe except that a tapered metal shaft fits into a metal seat when the valve is closed; available only in small sizes and are primarily use for precise throttling of flow.

AIR AND VACUUM RELIEF VALVE – a dual function air valve that permits entrance of air into a pipe being emptied, thus preventing a vacuum, and allows air to escape in a pipe while being filled or under pressure.

PINCH VALVE – a valve that is closed by pinching shot a flexible interior liner.

PLUG VALVE – a valve in which the movable element is a cylindrical or conical plug.

BALL VALVE – a valve consisting of the ball resting in a cylindrical seat. A hole is bored threw the ball to allow water to flow when the valve is open. When the ball is rotated 90 degrees, the valve is closed.

BUTTERFLY VALVE – a valve in which a disc rotates on a shaft as the Valve opens or closes. In the fully open position, the disc is parallel to the axis of the pipe.

CHECK VALVE – a valve designed to open in the direction of normal flow and close with reversal of flow. An improved check valve has substantial construction and suitable materials, is positive in closing, and permits no leakage in a direction opposite to normal flow.

ACTUATOR – a device, usually electrically or pneumatically powered, that is used to operate valves.

VALVE BOX – a metal, concrete, or composite box or vault set over a valve stem at ground surface to allow access to the stem so that the valve can be opened and closed. A cover for the box is usually provided at the surface to keep out dirt and debris.

STUDY QUESTIONS

1. Which type of valve should be installed at a dead-end water main?
    a. Vacuum valve
    b. Air valve
    c. Blow-off valve
    d. Pressure-relief valve

2. Which type of valve operates similar to a diaphragm valve?
    a. Vacuum relief valve
    b. Globe valve
    c. Pressure-relief valve
    d. Butterfly valve

3. Which type of valve can go from fully open to fully closed with a quarter turn?
    a. Plug valve
    b. Needle valve
    c. Globe valve
    d. Pinch valve

4. Foot valves are a special type of
    a. relief valve.
    b. control valve.
    c. check valve.
    d. plug valve.

5. Which type of valve would be best to use to precisely throttle flow?
    a. Globe valve
    b. Butterfly valve
    c. Rotary valve
    d. Needle valve

6. Which type of valve is used to isolate a pump on the suction side?
    a. Butterfly valve
    b. Globe valve
    c. Gate valve
    d. Ball valve

7. When fully opened, which type of valve will have the highest head loss?
    a. Gate valve
    b. Plug valve
    c. Globe valve
    d. Ball valve

8. Which type of valve will prevent the collapse of a pipe?
    a. Pressure-relief valve
    b. Needle valve
    c. Pinch valve
    d. Air-and-vacuum relief valve

9. List five types of valve used in water systems.
    Any five of the following types of valves: gate, globe, pressure relief, air & vacuum relief, diaphragm, pinch, rotary, butterfly, and check.

10. What type of valve is installed at frequent intervals in distribution piping so that small sections of water main may be shut off for maintenance or repair?
    Isolation Valve

11. What are the two principal types of throttling valves used in a water system?
    Pressure reducing valves and altitude valves.

12. What are the three types of power actuators commonly used to operate valves?
    Electric, hydraulic, and pneumatic

13. Records of each valve's location must include measurements from at least how many different permanent reference objects?
    Three

CHAPTER 10
FIRE HYDRANTS

FIRE HYDRANT – a device connected to a water main and provided with the necessary valves an outlet nozzle to which a fire hose may be attached. The primary purpose of a fire hydrant is to fight fires, is also used for washing down streets, filling water tank trucks, and flushing out water mains.

FIRE FLOW – the rate of flow, usually measured in gallons per minute (gpm) liter per minute (L/min), that can be delivered from a water distribution system at a specified residual pressure for firefighting. When delivery is to fire department pumpers, the specified residual pressure is generally 20 PSI (140 kPa).

DRY BARREL HYDRANT – a hydrant for which the main valve is located in the base. The barrel is pressurized with water only when the main valve is opened. When the main valve is close, the barrel drains. This type of hydrant is especially appropriate for use in areas where freezing weather occurs.

WET TOP HYDRANT – a dry barrel hydrant in which the threaded end of the main rod and the revolving or operating nut are not sealed from water in the barrel when the main valve of the hydrant is open, and the hydrant is in use.

DRY TOP HYDRANT – a dry barrel hydrant in which the threaded end of the main rod and the revolving or operating nut is sealed from water in the barrel when the main valve of the hydrant is in use.

BREAKAWAY HYDRANT – a two-part dry barrel post hydrant with a coupling or other device joining the upper and lower sections. The coupling and barrel are designed to break cleanly when the hydrant is struck by a vehicle preventing water loss and allowing easy repair.

WET BARREL HYDRANT – a fire hydrant with no main valve. Under normal, non-emergency conditions, the barrel is full and pressurize as long as the lateral piping to the hydrant is under pressure and the gate valve ahead of the hydrant is open. Each outlet has an independent valve that controls discharge from that outlet. The wet barrel hydrant is used mainly in areas where temperatures do not drop below freezing. The hydrant has no drain mechanism.

WARM CLIMATE HYDRANT – a fire hydrant with a two-piece barrel that is the main valve located at ground level.

FLUSH HYDRANT – a fire hydrant with the entire barrel in head a lull ground elevation. The head with operating not and outlet nozzle, is encased in a box with a cover that is flush with a ground line. Usually a dry barrel hydrant.

WATCH THE VIDEO
Hydrants – Types and parts
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=lIEruocRhOw

WSO Water Distribution Grades

UPPER SECTION – the upper part of the main hydrant assembly, including the outlet nozzle and outlet nozzle caps. The upper section is usually constructed of great cast iron. Also known as nozzle section or head.

OPERATING NUT – a nut, usually pentagonal or square, rotated with a wrench to open or close a valve or hydrant valve. May be a single component or it May be combined with a weather shield.

BONNET – the top cover or closure on the hydrant upper section. It is removable for the purpose of repairing or replacing the internal parts of the hydrant.

OUTLET NOZZLE – a threaded bronze outlet on the upper section of a fire hydrant, providing a point of hookup for hose lines or suction hose from hydrant to pumper truck.

LOWER SECTION – the part of a dry barrel hydrant that includes a lower barrel, the main valve assembly, and the base.

LOWER BARREL – the section of a hydrant that Carries the water for flow between the base and the upper section. Usually buried in the ground with the connection to the upper section approximately 2 inches above ground line.

MAIN VALVE – in a dry barrel hydrant, the valve in the hydrants base that is used to pressurize the hydrant barrel, allowing water to flow from any open outlet nozzle.

BASE – the inlet structure of a fire hydrant. An elbow shape piece that is usually constructed as a gray cast iron casting. Also known as the shoe, inlet, elbow, or foot piece.

TRAVEL STOP NUT – a nut used in dry barrel hydrants, that is screwed on the threaded section of the main rod. It bottoms at the base of the packing plate, or revolving nut, and terminates downward travel (opening) of the hydrant valve.

STRINGING HYDRANTS – the practice of dropping a weighted string down the barrel of a hydrant to check if the barrel has fully drained.

WATCH THE VIDEO
Hydrants – Installation and Repair
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=Bx3lLehvGRE

WSO Water Distribution Grades

STUDY QUESTIONS

1. It is standard practice to install fire hydrants on mains with diameters of or larger.
   - **a. 6 in. (150 mm)**
   - b. 8 in. (200 mm)
   - c. 10 in. (250 mm)
   - d. 12 in. (300 mm)

2. Most water systems use hydrants with two-diameter nozzles and one-diameter nozzle.
   - a. 2.0-in. (51-mm); 3.0-in. (76-mm)
   - b. 2.0-in. (51-mm); 4.0-in. (102-mm)
   - c. 2.5-in. (64-mm); 3.5-in. (89-mm)
   - **d. 2.5-in. (64-mm); 4.5-in. (114-mm)**

3. Miscellaneous use of fire hydrants
   - a. is never authorized.
   - b. is at the public's discretion on an as-needed basis.
   - **c. is generally discouraged but may be authorized in a controlled context.**
   - d. is a useful way of testing hydrants indirectly.

4. Which of the following is not a common classification of fire hydrants?
   - **a. Flow hydrant**
   - b. Warm-climate hydrant
   - c. Wet-barrel hydrant
   - d. Dry-barrel hydrant

5. The lower barrel should be buried in the ground so that the connection to the upper barrel is approximately above the ground line.
   - a. 12 in. (300 mm)
   - b. 1 in. (25 mm)
   - c. 6 in. (150 mm)
   - **d. 2 in. (50 mm)**

6. What type of fire hydrant is used in freezing climates?
   Dry-barrel hydrant

7. What is an auxiliary valve used for?
   Turning off the hydrant for repair or maintenance

8. Why is a fire hydrant operating nut five sided?
   To prevent operation using a standard socket wrench

9. In what type of fire hydrant are the entire barrel and head below ground elevation?
   Flush Hydrant

10. In the standard hydrant color scheme, what color are class A hydrants?
   Green

CHAPTER 11
WATER STORAGE

ELEVATED STORAGE – in any distribution system, storage of water in a tank supported on a tower above the surface of the ground.

FIRE DEMAND – the required fire flow and the duration for which it is needed, usually expressed in gallons or liters per minute for a certain number of hours. Also used to denote the total quantity of water needed to deliver the required fire flow for a specified number of hours.

OPERATING STORAGE – a tank supplying a given area and capable of storing water during hours of low demand, for use when demand exceed the pumps' capacity to deliver water to the district.

EMERGENCY STORAGE – storage volume reserved for catastrophic situations, such as a supply line break or pump station failure.

ELEVATED TANK – a water distribution storage tank that is raised above the ground and supported by post or columns.

STANDPIPE – a ground level water storage tank for which the height is greater than the diameter.

RESERVOIR – any tank or basin used for the storage of water. a ground level storage tank for which the diameter is greater than the height.

GROUND LEVEL TANK – in a distribution system, storage of water in a tank whose bottom is at or below the surface of the ground.

WATCH THE VIDEO
Water storage tanks - Types
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=LnieA9VOcWc

WSO Water Distribution Grades

HYDROPNEUMATIC SYSTEM – a system using an airtight tank in which air is compressed over water (separated from the air by a flexible diaphragm). the air imparts pressure to water in the tank and the attached distribution pipelines.

RISER – the vertical supply pipe to an elevated tank.

CATHARTIC PROTECTION – an electrical system for preventing corrosion to metals, particularly metallic pipe and tanks.

STUDY QUESTIONS

1. The height of water in three differently shaped tanks is 22.4 feet. Which tank will have the highest psi at the bottom?

a. The square tank
b. The rectangular tank
c. The cylindrical tank
d. It will be the same in all three tanks.

2. Which of the following is the proper detention time for disinfecting a water storage tank that is filled with already chlorinated water such that the free chlorine residual is 10 mg/L after the proper detention time is completed?

a. 4 hours
b. 6 hours
c. 8 hours
d. 24 hours

3. Which of the following is the proper detention time for disinfecting a water storage tank with water that is mixed with hypochlorite already in the tank such that the free chlorine is 10 mg/L after proper detention time is complete?

a. 6 hours
b. 8 hours
c. 12 hours
d. 24 hours

4. In what type of water storage system does water generally "float" on the system?

a. Elevated storage
b. Demand storage
c. Emergency storage
d. Operating storage

5. The _____may require the installation of obstruction lights or strobe lights on an elevated tank, depending on its height and location, to warn aircraft in the vicinity.

a. Occupational Safety and Health Administration
b. American Water Works Association
c. Federal Aviation Administration
d. Federal Communications Commission

6. What is the result of utilizing storage to minimize pumping?

More efficient use of energy and low operating cost

7. What is the term for a tank that rests on the ground and has a height that is greater than its diameter?
   Standpipe

8. What is the term for a vertical supply pipe to an elevated tank?
   Riser

9. Ponds, lakes, or basins are all examples of what type of raw-water storage container?
   Reservoir

CHAPTER 12
ELECTRICAL AND INSTRUMENTATION AND CONTROL SYSTEMS

ELECTROMAGNETICS – the study of the combined effects of electricity and magnetism.

STATIC ELECTRICITY – a state in which electrons have accumulated but are not going from one position to another.

DIRECT CURRENT DC - current that flows continuously in one direction.

ALTERNATING CURRENT AC – electrical current that reverses its direction in a periodic manner.

WATCH THE VIDEO
Electricity and Power
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=O8f7jBWW_h8


WSO Water Distribution Grades

PRIMARY INSTRUMENTATION – instruments required to operate the monitoring system by obtaining information relating to water flow, pressure, level, and temperature.

BUBBLER TUBE – a level sensing device that forces a constant volume of air into the liquid for which the level is being measured.

THERMALCOUPLE – a sensor, made of two wires of dissimilar metals, the measures temperature.

THERMISTOR – a semiconductor type of sensor that measures temperature.

VOLTAGE – a measure of electrical potential (electrical pressure), measured in volts. One volt will send a current of one ampere through the resistance of one ohm. In telemetry, the type of signal in which the electromotive force (measured in volts) varies as a parameter being measured varies.

CURRENT – the flow rate of electricity, measured in ampere. In telemetry the signal whose amperage varies as the parameter being measured varies.

RESISTANCE – a characteristic of an electrical circuit that tends to restrict the flow of current, similar to friction in a pipelined, measured in ohms.

POWER – a measure of the amount of work done per unit time by an electrical circuit, expressed in watts.

D'ARSONVAL METER – an electrical measuring device, consisting of an indicator needle attached to a coil of wire, placed within the field of a permanent magnet. The needle moves when an electrical current is passed through the Coil.

WATTMETER – an instrument for measuring real power in watts, stated as kilowatt hours (kWh).

SECONDARY INSTRUMENTATION – instruments that display information provided by sensors.

RECEIVER – the part of the meter that converts the signal from the sensor into a form that can be read by the operator; also called the receiver – indicator. In a telemetry system, the device that converts the signal from the transmission channel into a form that the indicator can respond to.

INDICATOR – the part of an instrument that displays information about a system being monitored. Generally, either an analog or digital display.

TELEMETRY – a system of sending data over long distances, consisting of a transmitter, a transmission channel, and a receiver.

REMOTE TERMINAL UNIT (RTU) – a computer terminal used to monitor the status of control elements, monitor and transmit inputs from instruments, and response to data request and the commands from the master station.

CONTROL TERMINAL UNIT (CTU) – the receiving device in a digital telemetry system.

MULTIPLEXING – the use of a single wire or channel to carry the information for several instruments or controls.

TONE FREQUENCY MULTIPLEXING – a method of sending several signals simultaneously over single channel.

SCANNING – a technique of checking the value of each of several instruments, one after another.

POLLING – a technique of monitoring several instruments over a single communications channel with a receiver that periodically asked each instrument to send current status.

DUPLEXING – a means by which an operator sends control signals back to the site of the transmitting sense are using a single transmission line.

FULL DUPLEX – capable of sending and receiving data at the same time.

HALF-DUPLEX – capable of sending or receiving data but not both at the same time.

SIMPLEX – related to a telemetry toward data transmission system that can move data through a single channel in only one direction.

CONTROL SYSTEM – a means of controlling equipment in a variety of ways.

MANUAL CONTROLS – the type of system control in which personnel manually operate the switches and levers to control equipment from the physical location of the equipment.

REMOTE MANUAL CONTROL – a system in which personnel in a central location manually controlled equipment at a distance site.

SEMIAUTOMATIC CONTROL – A System Equipment in which many actions are taken automatically but some situations require human intervention.

ON-OFF DIFFERENTIAL CONTROL – a mode of controlling equipment in which the equipment is turn fully on when measured parameter reaches a preset value, then turn fully off when it returns to another preset value.

PROPORTIONAL CONTROL – a mode of automatic control in which a valve or motor is activated slightly to respond to small vibrations in the system, but activated at a greater rate to respond to larger vibrations.

FEEDFORWARD PROPORTIONAL CONTROL – a control system that measures a variable and adjusts the equipment proportionally.

CLOSED LOOP CONTROL – a form of computerized control that automatically adjust for changing conditions to produce the correct output, so that operator intervention may be minimized.

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) – and methodology involving equipment that both acquires data on an operation and provide limited to total control of equipment in response to the data.

WATCH THE VIDEO
SCADA
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=cGAtcueNxnw

WSO Water Distribution Grades

STUDY QUESTIONS

1. Which basic electrical unit is used to measure a material's opposition to the flow of electricity?
    a. Ampere
    b. Ohm
    c. Volt
    d. Joule

2. All sensors that respond to liquid pressure will perform poorly if _____enter(s) the sensor.
    a. air
    b. corrosive chemicals from water treatment processes
    c. corrosive chemicals from piping
    d. iron bacteria

3. SCADA systems consist of what distinct components?
    a. Remote terminal units (RTUs), communications, and human— machine interface (HMI)
    b. Sensing instrument, RTUs, communications, and HMI
    c. Sensing instrument, RTUs, communications, master station, and HMI
    d. RTUs, communications, master station, and HMI

4. What is the electronic standard range?
    a. 4 to 20 mA DC
    b. 4 to 20 MA AC
    c. 0% to 100%
    d. 0 to 1 binary

5. The D'Arsonval meter is
    a. an amperometric meter.
    b. a type of pH meter.
    c. an analog (uses a needle) meter.
    d. a digital (number displays on unit) meter.

6. Which of the following is not an example of a secondary instrument?
    a. Telemetry device
    b. Multiplexing device
    c. pH monitor
    d. Indicator

7. Secondary instrumentation transmits information of what type?
    Information provided by sensors

8. What are the two types of temperature sensors commonly connected to instrumentation?

Thermocouples and thermistors

9. In what type of control system is each piece of equipment adjusted by the water system operator directly turning it on and off?

Direct manual control

10. What type of automatic control system measures a variable and adjusts the equipment proportionally?

Feedforward proportional control.

CHAPTER 13
MOTORS AND ENGINES

WATCH THE VIDEO
Motors
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=O-4Jw1m6Ghg


WSO Water Distribution Grades

SINGLE PHASE – alternating current (AC) power in which the current flow reaches a peak in each direction only once per cycle.

THREE-PHASE – alternating current AC power in which the current flow reaches three peaks in each direction during each cycle.

SQUIRREL CAGE INDUCTION MOTOR – the most common type of induction Electric Motor. The rotor consists of a series of aluminum or copper bars parallel to the shaft, resembling a Squirrel-cage period.

STATOR – the stationary member of an electric generator or motor.

SYNCHRONOUS MOTOR – an Electric Motor in which the rotor turns at the same speed as the rotating magnet field produced by the stator. This type of motor has no slip.

COMMUTATOR – a device that is part of the rotor of certain designs of motors and generators. The motor unit brushes rub against the surface of the spinning Commutator allowing current to be transferred between the rotor and the external circuits.

WOUND ROTOR INDUCTION MOTOR – a type of electrical motor, similar to a Squirrel-cage induction motor but easier to start and capable of variable speed operation.

STARTER – a motor control device that uses a small push button switch to activate a control relay, which sends electrical current to the motor.

REDUCED-VOLTAGE CONTROLLER – an electrical controller that uses less than the line voltage is to start the motor. Used when full line voltage Maya overload or damage the electrical system.

STUDY QUESTIONS

1. What is the simplest of all AC motors?
    a. Synchronous motor
    b. Squirrel-cage induction motor
    c. Wound-rotor induction motor
    d. Split-phase motor

2. Starters are typically used on motors
    a. larger than fractional horsepower.
    b. of fractional horsepower.
    c. of all horsepower ratings.
    d. when gasoline is unavailable.

3. In what type of motor is power applied to the windings in such a way that a revolving magnetic field is established?
    a. Synchronous motor
    b. Squirrel-cage induction motor
    c. Wound-rotor induction motor
    d. Split-phase motor

4. Operators should check the idle speed, oil pressure, water temperature, and all other operating indicators
    a. before starting the engine.
    b. exactly one hour after starting the engine.
    c. soon after starting the engine.
    d. on an as-needed basis.

5. What is the maximum ambient temperature at which motors are designed to function?
    104 degree's F (40 C)

6. What type of motor is used for most large pumps?
    Three-phase motor

7. What is the primary use of diesel engines?
    Power emergency generators for pumps stations and water treatment plants.

8. How should systems ensure that engines used for emergency service will function when needed?
    Exercise under load on a predetermined schedule.

9. What device is used when the starting current of a motor is so high that it may damage the electrical system or deprive other operating motors of sufficient current?
    Reduced-voltage controller

CHAPTER 14
PUMPS AND PUMPING STATIONS

VELOCITY PUMP – the general class of pumps that use a rapidly turning impeller to impart kinetic energy or velocity to fluids. The pump casing then converts this velocity head, in part, to pressure head.

IMPELLER – the rotating set of vanes that forces water through a pump.

CENTRIFUGAL PUMP – a pump consisting of impeller on a rotating shaft enclosed by a casing that has suction and discharged connections. The spinning impeller throws water outward at high velocity, and that casing shape converts this high velocity to a high pressure.

TURBINE PUMP – a centrifugal pump in which fixed guide vanes (diffusers) partially convert the velocity energy of the water into pressure head as the water leaves the impeller. A regenerative turbine pump.

SLIP – in a pump, the percentage of water taking into the suction end that is not discharged because of clearances in the moving unit. In a motor, the difference between the speed of the rotating magnetic field produced by the Stator and the speed of the rotor.

VERTICAL TURBINE PUMP – a centrifugal pump, commonly of the multistage diffuser type, in which the pump shaft is mounted vertically.

WATCH THE VIDEO
Pumps - Types
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=8MJ4qd9A9T0


Water Distribution
Pumps Training for \

RECIPROCATING PUMP – the type of positive displacement pump consisting of a closed cylinder containing a piston or plunger to draw liquid into the cylinder through an inlet valve and force it out through an outlet valve. When the piston acts on the liquid in one end of the cylinder, the pump is termed single-action; when the piston acts in both ends, the pump is term double-action.

ROTARY PUMP - a type of positive displacement pump consisting of elements resembling gears that rotate in a closed fitting pump case. The rotation of these elements alternately draws in and discharges the water being pumped. Such pumps act with neither suction nor discharge valves, operate at almost any speed, and do not depend on centrifugal forces to lift the water.

FOOT VALVE – a check valve placed in the bottom of the suction pipe of a pump, which opens to allow water to enter the suction pipe but closes to prevent water from passing out of it at the bottom end.

CAVITATION – a condition that can occur when pumps are run too fast or water is forced to change direction quickly. During Cavitation, a partial vacuum forms near the pipe wall or Impeller blade, causing potentially rapid pitting of the metal.

TACHOMETER GENERATOR – a sensor for measuring the rotational speed of a shaft.

SINGLE- SECTION PUMP – a centrifugal pump in which the water enters from only one side of the impeller.

DOUBLE-SECTION PUMP – a centrifugal pump in which the water enters from both sides of the impeller.

WEAR RINGS – rings made of Brass or bronze placed on the impeller and/or casing of the centrifugal pump to control the amount of water that is allowed to leak from the discharge to the suction side of the pump.

SHAFT – the bearing-supported rod in a pump, turned by the motor, on which the impeller is a mounted. The portion of a butterfly valve attached to the disc of and a valve actuator. The shaft opens and closes the disc as the actuator is operated.

PACKING – rings of graphite-impregnated cotton, flax or synthetic materials, used to control leakage along a valve stem or a pump shaft.

LANTERN RING – a perforated ring placed around the pump shaft in the stuffing box. Water from the pump discharge is piped to the lantern ring so that it will form a liquid seal around the shaft and lubricate the packing.

MECHANICAL SEAL – a seal placed on that pump shaft to prevent water from leaking from the pump along the shaft. Also prevents air from entering the pump. Mechanical seals are an alternative to packing rings.

WATCH THE VIDEO
Pumps – Centrifugal
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=fpdxlekThE0

WSO Water Distribution Grades

BEARING – antifriction device used to support and guide pump and motor shafts.

COUPLING – a device that connects the pump shaft to the motor shaft.

STUDY QUESTIONS

1. The "heart" of a pump is called the
    a. volute case.
    b. impeller.
    c. motor.
    d. pump.

2. Which device serves the same function as the packing?
    a. Inline suction gland
    b. Packing gland
    c. Mechanical seal
    d. Lantern seal

3. Which of the following is used to stop air leakage into the casing around a pump shaft?
    a. Packing gland
    b. Lantern ring
    c. Seals
    d. Shaft sleeves

4. Which of the following is at the top of a stuffing box?
    a. Packing gland
    b. Lantern ring
    c. Mechanical seal
    d. Seal cage

5. Which assembly holds the lantern ring and packing?
    a. Shaft assembly
    b. Casing ring assembly
    c. Packing gland casing
    d. Stuffing box

6. Which type of valve is used to isolate a pump on the suction side?
    a. Butterfly valve
    b. Globe valve
    c. Gate valve
    d. Ball valve

7. Packing is designed to
    a. add lubricant to the shaft.
    b. expand and deteriorate with normal use.
    c. protect the shaft.
    d. wear and deteriorate with normal use.

8. Why is it so important to monitor the speed of a variable-speed pump?
    a. To prevent excessive temperatures from developing
    b. To prevent vibration from developing
    c. To prevent speed oscillation from occurring
    d. To prevent cavitation from occurring

9. List three disadvantages of turbine pumps.

Any three of the following: high initial cost, high repair costs, the need to lubricate support bearings located within the casing, inability to pump water containing any suspended matter, an efficiency that is at best limited to a very narrow range of discharge flow and head conditions

10. What type of pump has an impeller rotating in a channel of constant cross-sectional area, which imparts mixed or radial flow to the water?

Vertical turbine pump

11. What type of pump uses closely meshed gears, vanes, or lobes rotating within a close-fitting chamber?

Rotary pump

12. To prevent excessive circulation of water between the impeller discharge and suction areas, what components are used to create a flow restriction?

Wear rings

13. To prevent leakage at the point where the shaft protrudes through the case, what components may be used to seal the space between the shaft and the case?

Either packing rings or mechanical seals.

CHAPTER 15
METERS

WATER METER – a device installed in a pipe under pressure for measuring and registering the quantity of water passing through.

WATCH THE VIDEO
Water Meters -Types
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=Dn-N15ccJnE

WSO Water Distribution Grades

POSITIVE DISPLACEMENT METER – A type of meter consisting of a measuring chamber of known size that measures the volume of water flowing through it by means of a moving piston or disk.

NUTATING DISK METER - a type of positive displacement meter that uses a hard rubber disc that wobbles (rotates) in proportion to the volume of water flowing through the meter.

COMPOUND METER – a water meter consisting of two single meters of different capacities and a regulating valve that automatically diverts all or part of the flow from one meter to the other. The valve senses flow rate in shifts the flow to the meter that can most accurately measure it.

CURRENT METER – a device for determining flow rate by measuring the velocity of moving water. Turbine meters, propeller meters, and multi jet meters are common types. Compare with positive displacement meter.

DETECTOR CHECK METER – a meter that measures daily flow but allows emergency flow to bypass the meter. Consist of a weight loaded check valve in the main line that remains closed under normal usage and a bypass around the valve containing a positive displacement meter.

TURBINE METER - a meter that measures flow rates by measuring the speed at which the turbines spins in water, indicating the velocity at which the water is moving through a conduit of known cross-sectional area.

MULTI JET METER – a type of current meter in which a vertically mounted turbine wheel is spun by jets of water from several ports around the wheel.

PROPELLER METER – a meter that measures flow rate by measuring the speed at which a propeller spins as an indication of the velocity at which the water is moving through a conduit of known cross sectional area.

PROPORTIONAL METER – any flow meter that diverts a small portion of the main flow and measures the flow rate of that portion as an indication of the rate of the main flow. The rate of the diverted flow is proportional to the rate of the main flow.

VENTURI METER – a pressure-differential meter use for measuring flow of water or other fluids through closed conduits or pipes, consisting of a venturi tube registering device. The difference in velocity head between the entrance and the contracted throat of the tube is an indication of the rate of flow.

ORIFICE METER – a type of flow meter consisting of a section of pipe blocked by a disc pierced with a small hole or orifice. The entire flow passes through the orifice, creating a pressure drop proportional to the flow rate.

MAGNETIC METER – a flow measuring device in which the movement of water induces an electrical current proportional to the rate of flow.

ULTRASONIC METER – a meter that utilizes sound-generating and receiving sensors (transducers) attached to the sides of the pipe.

STUDY QUESTIONS

1. What type of meter is most common for individual service lines?
   Positive displacement meter

2. What are the advantages of a venturi meter?
   low friction loss, accurate, low maintenance

3. When are magnetic meters used?
   When flow is dirty or corrosive

4. How many meters can be tested on most test benches?
   Multiple meters can be tested simultaneously

5. Which of the following is not a meter type commonly used on water systems?
   a. Proportional
   b. Current
   c. Magnetic
   d. Inverse

6. Positive-displacement meters_____when they are excessively worn.
   a. do not register
   b. under-register
   c. over-register
   d. register intermittently

7. When using turbine meters, clogging of the wheel's blades can be prevented by installing a(n) ahead of the meter.

a. venturi device
b. impeller
c. strainer
d. restrictor

8. What type of meter is used for -service where daily use is relatively low but where very high flow rates may be required in an emergency?

a. Magnetic meter
b. Detector-check meter
c. Venturi meter
d. Compound meter

9. What type of meter is used for customers that have wide variations in water use?

a. Magnetic meter
b. Detector-check meter
c. Venturi meter
d. Compound meter

CHAPTER 16
BASIC CHLORINATION

DISINFECTION – the water treatment process that kills disease causing organisms in water, usually by addition of chlorine.

C x T VALUE – the product of the residual disinfecting concentration C, in milligrams per liter, and the corresponding disinfecting contact time T in minutes. Minimum C x T values are specified by the surface water treatment rule as a means of ensuring adequate kill or inactivation of pathogenic microorganisms in water.

CHLORINATION – the process of disinfecting water through the controlled use of chlorine; usually accomplished by adding gaseous chlorine, liquid sodium hypochlorite, or solid calcium hypochlorite.

CHLORINE DEMAND – the amount of chlorine that will combine with organic and inorganic materials to form chlorine compounds when added to water; once the demand is satisfied, additional chlorine will not combine with the organic and inorganic materials.

CHLORINE RESIDUALS – the total of all the compounds with disinfecting properties, plus any remaining on uncombined chlorine.

BREAKPOINT – the point at which the chlorine dosage has satisfied the chlorine demand.

CHLORINE CYLINDER – a container that holds 150 pounds of chlorine and has a total filled weight of 250-285 pounds.

TON CONTAINER - a reusable, welded tank that holds 2,000 pounds of chlorine. Containers weigh about 3,700 pounds when full and are generally 30 inches in diameter and 80 inches long.

WATCH THE VIDEO
Chlorine – Transportation and Storage
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=_ucGhqT-WFc

WSO Water Distribution Grades

CHLORINATOR – any device that is used to add chlorine to water.

INJECTOR – the portion of a chlorination system that feeds the chlorine solution into a pipe under pressure.

DIFFUSER – a section of a perforated pipe or porous plates used to inject a gas, such as carbon dioxide or air, under pressure into water. The type of pump.

CHLORINE EVAPORATOR – a heating device used to convert liquid chlorine to gas chlorine.

HYPOCHLORINATION - chlorination using solutions of calcium hypochlorite or sodium hypochlorite.

TRACER STUDY – a study using a substance that can readily be identified in water such as die to determine the distribution and rate of flow in a basin, pipe, or channel.

STUDY QUESTIONS

1. One of chlorine's advantages is that it
    a. is not influenced much by pH changes.
    b. does not produce chlorinated by-products.
    c. has a persistent residual.
    d. does not cause taste and odor problems.

2. Chlorine gas is_____times heavier than air.
    a. 1.5
    b. 2.5
    c. 3.5
    d. 4.5

3. After a water storage tank has been chlorinated, which bacteriological test must prove negative before the tank is put back into service?
    a. Gram-negative test
    b. HPC test
    c. Coliform test
    d. Chloramine test

4. Sodium hypochlorite (NaOCl) solution is available with _____ available chlorine.
    a. 2-5%
    b. 5-20%
    c. 25-50%
    d. 50-70%

5. Booster chlorination is chlorine added
    a. in the coagulation mixing chamber.
    b. before the filters.
    c. at the clear well.
    d. somewhere in the distribution system.

6. Chlorine cylinders hold_____of chlorine.
    a. 100 1b (45 kg)
    b. 150 1b (68 kg)
    c. 200 1b (97 kg)
    d. 350 1b (159 kg)

7. Why would a system need a booster chlorination station?

To maintain a more constant chlorine residual throughout the system.

8. In the C x T equation, what does C represent?

A known concentration of disinfectant.

9. What is the term for the total of all the compounds with disinfecting properties, plus any remaining uncombined chlorine?

Chlorine residual

10. What is the term for a venturi device that pulls chlorine gas into a passing stream of dilution water, forming a strong solution of chlorine and water?

injector

11. What is the term for a chlorination method increasingly used by water treatment plants because of its relative safety (as compared to gaseous chlorine) and its ease of use?

Hypo-chlorination

CHAPTER 17
SYSTEM OPERATIONS

WATCH THE VIDEO
Maintaining Water Quality in the Distribution System
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=3uFDqwJugu0


Water Distribution
Maintaining Water (

STUDY QUESTIONS

1. Precipitative softening water treatment plants try to end up with distribution system water that is
   - **a. slightly scale forming.**
   - b. moderately scale forming.
   - c. neutral.
   - d. in equilibrium.

2. There are two major objectives for drinking water distribution system operational policies: (1) maintain water quality from the point of entry into the distribution system to the point of use and (2)
   - a. keep operating expenses under budget.
   - b. make sure customers do not waste water.
   - c. educate customers to about water safety.
   - **d. maintain adequate pressure and deliver adequate flow.**

3. The goal of a well-managed distribution system should be to provide water to customers' taps that has_____ from the point of entry into the system.
   - **a. not changed**
   - b. gained valuable nutrients
   - c. decreased dramatically in pH
   - d. become better tasting

4. What factor generally determines the need for larger mains?
   - **a. Fire flow requirements**
   - b. pH concerns
   - c. Potability issues
   - d. Number of customers served

5. Which of the following is not a major factor in storage facility design?
   - a. Preventing dead zones
   - b. Selecting and maintaining the correct materials of construction
   - **c. Staying under budget to allow for design modifications**
   - d. Providing adequate and appropriate cathodic protection to prevent or control corrosion

6. Where do many distribution system water quality problems develop?
   - **Finished water storage facility**

7. What is a hydraulic system model?
   A computer simulation of the behavior of physical facilities and water use within the distribution system

8. What may occur at pressure zone boundaries?
   May form dead-end boundaries

9. What should be considered when designing storage facilities?
   Inspection, maintenance, monitoring, and mixing practices

10. In assessing water quality, what rule is of particular interest to distribution system operators?
    Lead and Copper rule

CHAPTER 18
WATER QUALITY TESTING

GRAB SAMPLE – a single water sample collected at one time from a single point.

DISSOLVED OXYGEN (DO) – The oxygen dissolved in water, wastewater, and other liquid, usually expressed in milligrams per liter parts per million or percentage of saturation.

COMPOSITE SAMPLE – a series of individual or grab samples taken at different times from the same sampling point and mix together.

REPRESENTATIVE SAMPLE – a collection sample that accurately reflects the composition of water to be tested.

CHAIN OF CUSTODY – a written record of the sample's history from the time of collection to the time of analysis and subsequent disposal.

WATCH THE VIDEO
Water Sampling - Coliform
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=Fu9Pr1u7je4

WSO Water Distribution Grades

STUDY QUESTIONS

1. Samples to be tested for coliforms are collected in plastic bottles that must contain
    a. sodium thiocarbonate.
    b. sodium thiooxalate.
    c. sodium thiosulfate.
    d. sodium thiocyanate.

2. The volume of a sample for coliform compliance is
    a. 100 mL.
    b. 200 mL.
    c. 300 mL.
    d. 0; there is no volume compliance for coliforms.

3. If a water sample is not analyzed immediately for chlorine residual, it is acceptable if it is analyzed within
    a. 10 minutes.
    b. 15 minutes.
    c. 20 minutes.
    d. 30 minutes.

4. The best choice to collect a water sample from a customer's faucet when responding to a complaint would be
   a. faucet without threads.
   b. faucet that can swivel.
   c. single-lever handle faucet.
   d. faucet with an aerator.

5. When measuring for free chlorine residual, which method is the quickest and simplest?
   a. DPD colorimetric method
   b. Orthotolidine method
   c. Amperometric titration
   d. 1,2 nitrotoluene di-amine method

6. _____is a single-volume sample collected at one time from one place.
   a. DPD colorimetric method
   b. grab sample
   c. random sample
   d. continuous sample

7. Under the Ground Water Rule (GWR), what type of sampling is required for larger systems for chlorine residual?
   Continuous

8. What are three broadly classified areas from which samples are generally collected?
   Raw-water supply, treatment plant, and distribution system

9. Consistency among laboratories in analytical results is overseen by state primacy programs and by what organization?
   USEPA

10. If samples arrive at a laboratory past the specified holding time following collection, the laboratory must do what?
   Reject the samples

CHAPTER 19
BACKFLOW PREVENTION AND CROSS-CONNECTION CONTROL

BACKFLOW – a hydraulic condition, caused by a difference in pressure, in which non-potable water or other liquids flow into a potable water system.

BACKPRESSURE – a condition in which a pump, boiler, or other equipment produces a pressure greater than the water supply pressure.

BACKSIPHONAGE – a condition in which the pressure in the distribution system is less than the atmospheric pressure, which allows contamination to enter a water system through cross-connection.

CROSS-CONNECTION – any arrangement of pipes, fittings, fixtures, or devices that connects a nonpotable system to a potable water system.

ACTUAL CROSS-CONNECTION – any arrangement of pipes, fitting, or devices that connects a potable water supply directly to a non-potable source at all times.

POTENTIAL CROSS-CONNECTION – any arrangement of pipes, fittings, or devices that indirectly connects a potable water supply to a non-potable source. This connection may not be present at all times, but it is always there potentially.

WATCH THE VIDEO
Backflow Prevention
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=wrGIu_ZiBJk

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AIR GAP – in plumbing, the unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or outlet supplying water to a tank, plumbing fixture, or other container and the overflow rim of that container.

REDUCED PRESSURE ZONE BACKFLOW-PREVENTER (RPZ) – a mechanical device consisting of two independently operating, spring loaded check valves with a reduced pressure zone between the check valves. Designed to protect against both Backpressure and backsiphonage.

DOUBLE CHECK VALVE BACKFLOW-PREVENTER – a mechanical designed basically the same way as the reduce pressure zone backflow-preventer but without the relief valve.

VACUUM BREAKER – a mechanical device that allows air into the piping system, thereby preventing backflow that could otherwise be cause by the siphoning action created by a partial vacuum.

ATMOSPHERIC VACUUM BREAKER – a mechanical device consisting of a float check valve in an air inlet port designed to prevent backsiphonage.

PRESSURE VACUUM BREAKER – a device designed to prevent backsiphonage, consisting of one or two independently operating, spring loaded check valves and an independent operating, spring loaded air inlet valve.

WATCH THE VIDEO
Backflow Prevention Devices
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=SGH09fgrry4


WSO Water Distribution Grades

STUDY QUESTIONS

1. The correct protective methods for backflow-prevention devices, in order of decreasing effectiveness, are
   a. air gap, vacuum breaker (VB), reduced pressure zone backflow preventer (RPZ), and double check valve assembly (DCVA).
   b. air gap, VB, DCVA, and RPZ.
   c. air gap, RPZ, VB, and DCVA.
   d. air gap, RPZ, DCVA, and VB.

2. What is the likelihood of a swimming pool creating a cross-connection that could contaminate a potable water supply?
   a. Impossible
   b. Not very likely
   c. Moderately likely
   d. Highly likely

3. What is the likelihood of a sewage pump creating a cross-connection that could contaminate a potable water supply?
   a. Impossible
   b. Not very likely
   c. Moderately likely
   d. Highly likely

4. What type of backflow preventer consists of two spring-loaded check valves with a pressure-regulated relief valve located between them?
   a. Vacuum breaker
   b. Atmospheric vacuum breaker
   c. Double check valve backflow preventer
   d. Reduced pressure zone backflow preventer

5. What is a utility's first line of defense against potential legal liability in case of public health problems resulting from a cross-connection?

a. Notifying the public
b. Maintaining complete records
c. Testing the problem
d. Correcting the issue

6. What is the best method to prevent backflow?

Air gap

7. How frequently do most regulations require testing of backflow prevention devices?

annually

8. What is a cross-connection?

Any connection between the potable water supply and a source of contamination

9. Give two examples of cross-connections.

Examples of correct answers include cooling towers, boilers, service sinks

10. Give some examples of causes of backflow.

Examples of correct answers include high-pressure boiler, pressurized chemical storage tank, and hot-water recirculation system.

11. What is the term for a cross-connection for which something must be done to complete the connection?

Potential cross-connection

CHAPTER 20
INFORMATION MANAGEMENT AND SYSTEM MAPPING

COMPREHENSIVE MAP – a map that provides a clear picture of the entire distribution system. It usually indicates the locations of water mains, fire hydrants, valves, reservoirs and tanks, pumping stations, pressure zone limits, and closed valves at pressure zone limits.

SECTIONAL MAP – a map to provide a detailed picture of the portion (section) of the distribution system. Reveals the locations and valving of existing mains, location of fire hydrants, and location of active service lines.

PLAT – a map showing street names, mains, main sizes, numbered valves, and numbered hydrants for the plat-and-list method of setting up valve in hydrant maps.

VALVE AND HYDRANT MAP – the mapped record that pinpoints the location of valves/hydrants throughout the distribution system. Generally, of plat-and-list or intersection type.

PLAT AND LIST METHOD – a method of preparing valve and hydrant maps. Plat is the map position, showing mains, valves, and hydrants. List is the text portion, which provides appropriate information for items on the plat.

PLAN AND PROFILE DRAWINGS – engineering drawings showing depth of pipe, pipe locations (both horizontal and vertical displacements), and the distance from a reference point.

AUTOMATED MAPPING/FACILITY MANAGEMENT/GEOGRAPHIC INFORMATION SYSTEM (AM/FM/GIS) – a computerized system for collecting, storing, and analyzing water system components for which geographic location is an important characteristic.

WATCH THE VIDEO
GIS for Water Systems
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=2OuLIuSXO_k

WSO Water Distribution Grades

STUDY QUESTIONS

1. Which type of maps should not overlap each other?
   a. Index maps
   b. Comprehensive maps
   c. Construction maps
   d. Sectional maps

2. Comprehensive maps of medium to large systems generally have scales ranging from
    a. 250—500 feet to 1 inch.
    b. 500—1,000 feet to 1 inch.
    c. 1,000—1,500 feet to 1 inch.
    d. 1,500—2,000 feet to 1 inch.

3. Sectional maps generally have scales ranging from
    a. 50—100 feet to 1 inch.
    b. 100—200 feet to 1 inch.
    c. 200—250 feet to 1 inch.
    d. 250—400 feet to 1 inch.

4. A comprehensive map should be
    a. compact enough to fit in a folder.
    b. as large as possible.
    c. as detailed as possible.
    d. written in technical language so that only engineers can read it.

5. On a plan and profile drawing, what does the abbreviation EL mean?
    a. English language
    b. Estimated length
    c. Electric
    d. Elevation

6. What type of map is also referred to as a wall map?
    Comprehensive map

7. What type of map, commonly called a plat, is a series of maps covering sections of the water system?
    Sectional Map

8. What is the term for a computerized program used to manage data relating to geographic locations within a water distribution system?
    Automated mapping/facility management/geographic information system (AWFWGIS)

CHAPTER 21
SAFETY, SECURITY, AND EMERGENCY RESPONSE

PERMIT REQUIRED SPACE – a space defined by the occupational safety and hazard administration (OSHA) as having one or more of the following characteristics; contains, or has a potential to contain, a hazardous atmosphere; contains a material that has the potential for and engulfing an entrant; has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section; and/or contains any other recognized serious safety or health hazard.

NON-PERMIT REQUIRED SPACE – a space defined by the occupational safety and health administration as not having any of the risk associated with a permit required space.

WATCH THE VIDEO
Confined Space Safety
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=zLLNV9qfORg

WSO Water Distribution Grades

WATCH THE VIDEO
Traffic Control
https://www.youtube.com/watch?list=PL9NfaH39Z9FJlWTHBhH0-xIqwfxRjEscS&v=yPc50igYUkM

WSO Water Distribution Grades

STUDY QUESTIONS

1. If an excavation on a road requires that one of the lanes be closed and the speed limit is 25 mph (40 km/h), how many cones are required to divert the traffic?
   - **a. 6**
   - b. 9
   - c. 13
   - d. 15

2. If an excavation on a road requires that one of the lanes be closed and the speed limit is 45 mph (72 km/h), how many cones are required to divert the traffic?
   - a. 9
   - **b. 13**
   - c. 15
   - d. 18

3. Who is responsible for maintaining safe working conditions?
    a. Upper management
    b. Operations personnel
    c. Supervisors
    d. All water utility personnel

4. What item should be worn whenever a worker is in a trench or has someone working above him or her, or when he or she is near electrical equipment?
    a. Gloves
    b. A hardhat
    c. Respiratory equipment
    d. A reflective vest

5. When lifting a load that is too heavy or too large to lift comfortably,
    a. get a firm hold on the object before lifting.
    b. bend at the knees and lift with the legs.
    c. use a mechanical device to assist in lifting heavy objects.
    d. maintain good footing, with feet about shoulder-width apart, while lifting.

6. Which of the following is not an example of an accidental disaster that might disrupt water utilities?
    a. Earthquake
    b. Chemical spill
    c. Fire
    d. Transportation accident

7. What is the most common injury of distribution system workers?
    Back injury

8. Would a meter pit be a permit-required confined space?
    Yes, it may contain a hazardous atmosphere.

9. Under what conditions is cave-in protection always required?
    All excavation at least 5 ft (1.5 m) deep.

10. What three chemicals are commonly used to disinfect mains and other facilities?
    Calcium hypochlorite, liquid chlorine, and sodium hypochlorite

CHAPTER 22
PUBLIC RELATIONS

PUBLIC RELATIONS – The methods and activities employed to promote a favorable relationship with the public.

STUDY QUESTIONS

1. What are the basic elements to good customer relations?
   Good communications, caring, and courtesy

2. What should meter readers do when asked a question to which they don't know the answer?
   Tell the customer that they don't know but will find out and get back to them.

3. What should customers be told when water service must be temporarily stopped?
   Notify them with enough time so they can prepare

4. ____ generally presents the greatest exposure to the public and can have the greatest impact in ensuring public confidence.
   a. Formal media campaigns
   b. Water distribution personnel
   c. Large-scale public relations projects
   d. Political campaigns

5. _____should be viewed as an opportunity to improve communications and build goodwill.
   a. The initial customer contact
   b. A response to a customer complaint
   c. Every customer contact
   d. A meter reading

6. If damage to a customer's property occurs,
   a. customers should be told how to repair the damage.
   b. customers should be put in touch with a professional who can repair the damage.
   c. It is the customer's responsibility to fix the damage.
   d. property must be restored to its original state before workers leave the site.

7. Shutoffs should be scheduled
   a. at the utility's convenience.
   b. during holidays.
   c. on weekends.
   d. to coincide with low-water-use hours.

8. What is the general rule for talking to reporters
   a. Don't do it.
   b. Keep answers brief.
   c. Make only positive statements.
   d. Validate all statements with relevant statistics.