

The study guide is for water distribution operator practices involving primary skill and knowledge levels. The outline topics are the general subjects which are the basis for the examination questions. The applicant should be knowledgeable of the subject matter outlined and contained in the reference material list.

- PUBLIC HEALTH ASPECTS
  - Define potable water
  - Define contamination and list possible sources
  - Define microbiological characteristics of water
  - Define pathogenic bacteria
  - Define coliform bacteria
  - Define sterilization
  - Define disinfection
    - Physical and chemical properties of chlorine
    - Recommended free chlorine concentration in water distribution system (1.0 mg/l)
    - Chlorinator operation and maintenance
  - Define physical characteristics of water
    - Turbidity
    - Odor and taste – rotten egg smell (H<sub>2</sub>S)
    - Temperature
    - Color
- Define chemical characteristics of water
  - Milligrams per liter (mg/l) or parts per million (ppm)
    - Milligrams = weight
    - Liter = volume
  - pH – acid range and base range
  - Inorganic contaminants (many are metals)
  - Organic contaminants (pesticides, herbicides)
  - Fluoride – proper concentration (1.2 mg/l)
  - Iron and manganese – problem concentrations
- Define radiological characteristics of water
- Basic disinfection practices of water mains (minimum concentration 50 mg/l)

- DISTRIBUTION SYSTEM
  - Basic cross-connection control
    - Air gap
    - Vacuum breakers
    - Reduced pressure zone backflow preventor
  - Minimum separation of water and sewer lines (10 feet horizontal)
  - Minimum depth of cover on waterlines (7.5 feet)
  - Minimum pressure – 20 (units of measure – p.s.i.)
  - Necessity of minimum waterline size (6 inches) for fire protection
  - Friction factor or c value (factors influencing)
  - Carrying capacity reduced by tuberculations (rust deposits)
    - Water quantity (flow rate) in pipe = cubic feet/second
    - Water velocity in pipe = feet/second
  - Scaling deposits of lime – factors influencing
  - Types of pipes – plastic, cast iron, steel, concrete, and asbestos-cement
    - Composition
    - Strength rating
    - Jointing materials and methods
    - Proper installation, backfill, and tamping
  - Corrosion control (use of dissimilar metals increases corrosion)
  - Looping of water distribution lines
  - Basic valve operation and maintenance
    - Types of valves and functions – diaphragm, globe, rotary, slide, check, relief, altitude, pressure reducing
    - Proper repair
    - Proper opening and closing of valves
  - Fire hydrants
    - Dry barrel type
    - Wet barrel type
    - Proper installation
    - Proper technique to reduce flow
  - Customer service lines
    - Proper installation
    - Tapping techniques
  - Water main chlorination and flushing

- PUMPING STATIONS, PUMPS, AND APPURTENANCES
  - Types and classification of pumps
    - Centrifugal pumps
      - Mechanical parts and function
      - Proper packing techniques
      - Pump priming
      - Shutoff head
      - Conditions causing overheating of motors
      - Conditions causing loss of suction
    - Positive displacement
      - Mechanical parts and function
      - Operation and maintenance
  - Booster pumping
    - Function
    - Control systems
  - Reservoirs
    - Protection from vandalism
    - Manhole for entry-overlapping and locked
    - Vents and overflows screened
- METERS
  - Various types
    - Displacement meters – mechanical parts
    - Venturi meter – pressure differential
    - Compound meter – low and high flows
  - Proper meter installation
  - Meter testing and maintenance
  - Meter reading
- SAFETY
  - Housekeeping techniques
  - Handling hazardous materials
  - Construction safety
  - Trench construction and shoring
  - Ventilation of all underground areas – pits, vaults, manholes
  - No smoking in manholes, vaults, pits
  - First aid

Study Guide for Grade1A, 1 and 2  
Water Distribution System Operators

- STATE AND FEDERAL SAFE DRINKING WATER ACT REGULATIONS
  - Responsibility (lawsuits and fines)
  - Sampling responsibility lies with provider
  - Requirements for submission of plans and specifications (required for new facilities, but also for changes in existing systems)
  - Sampling frequencies – physical, chemical, microbiological, radiological
    - Microbiological – number of monthly samples from distribution system based on population
    - Proper sampling technique for microbiological sample
    - Radiological sampling – 4 samples collected during the year and combined to form one composite sample
  - Proper written reports
  - Public notification responsibilities

#### REFERENCES

1. “Water Distribution Operator Training Handbook,” American Water Works Association Manual No. 3P-7M-5/78-20103
2. “Environmental Data Sheets for Municipal Utilities,” North Dakota Water and Pollution Control Conference
3. “Cross-Connection Control Manual, EPA Manual 430/9-73-002
4. North Dakota Administrative Code Title 33 – Department of Health Chapter 33-17, Public Water Supply Systems (Safe Drinking Water Regulations)

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**TYPICAL EXAMINATION QUESTIONS**  
**Class 1 Water Distribution**

1. One cubic foot of water contains \_\_\_\_\_ gallons.
  - a. 6.0
  - b. 7.5
  - c. 10.0
  - d. 4.5
  
2. A fire hydrant should be closed slowly to avoid:
  - a. Excessive wear
  - b. Water hammer
  - c. Excessive head loss
  - d. Injury to operator
  
3. Potable water is defined as:
  - a. Safe drinking water for consumer use
  - b. Water that is transported by truck
  - c. Water that is used in industry
  - d. Water that is used in stabilization ponds
  - e. Unsafe water and not fit for consumer use
  
4. The minimum separation between municipal water mains and sanitary sewers shall be:
  - a. Installation in a common trench
  - b. 5 feet horizontal separation
  - c. 10 feet horizontal separation
  - d. 15 feet horizontal separation
  - e. 25 feet horizontal separation

ANSWERS:

1. b    2. b    3. a    4. c

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## PROBLEMS:

1. How many gallons of water are contained in a 500-foot length of 12-inch main?  
( $V = \pi r^2 h$ ) (7.5 gallons = 1 cubic foot) ( $\pi = 3.14$ )
- a. 8336.6  
b. 4556.2  
c. 2943.8  
d. 5887.6  
e. 1002.2
2. In Problem 1, once the volume in gallons is known, calculate the number of pounds of chlorine (HTH) that must be used to disinfect the main to 50 milligrams per liter (mg/l). Assume HTH is 100% chlorine.
- A. 4.46  
B. 1.23  
C. 2.46  
D. 5.00  
E. 6.03

## ANSWERS:

5. c.

2943.8 gallons Find the volume of the main in cubic feet by

using the formula:  $V = \pi r^2 h$ . Then multiply the number of cubic feet by 7.5 gallons in the main. All terms must be in feet; therefore, the pipe diameter 12 inches is one foot. The radius would be 0.5 feet.

$$V = \pi r^2 h$$

$$V = (3.14) (.5 \text{ feet}) (.5 \text{ feet}) (500 \text{ feet})$$

$$V = 392.5 \text{ cubic feet OR}$$

$$V = 392.5 \text{ feet}^3$$

Convert cubic feet to gallons:

$$392.5 \text{ cubic feet} \times 7.5 \text{ gallons} = 2943.8 \text{ gallons}$$

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cubic foot

6. b.

1.23 pounds                      8.34 pounds/1,000,000 gallons  
represents the number of pounds of chemical needed to be  
added to 1,000,000 gallons to get a concentration of 1  
milligram per liter. Therefore, if the concentration desired (50  
mg/l) is multiplied by 8.34 lb./1,000,000 gallons, and that  
answer multiplied by the actual number of gallons in the main,  
we should obtain the number of pounds necessary.

$$\frac{50 \text{ mg/l} \times 8.34 \text{ lbs.} \times 2943.8 \text{ gal}}{1,000,000 \text{ gal.}} = 1.23 \text{ lbs. OR} \quad 1.23 \text{ pounds}$$

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