



Wisconsin Department of Natural Resources Municipal Waterworks Operator Certification

Distribution Study Guide

December 2006 Edition (Revised February 2016)

Subclass D

Wisconsin Department of Natural Resources
Bureau of Science Services
Operator Certification Program
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Preface

This operator's study guide represents the results of an ambitious program. Operators of water supply facilities, regulators, educators and local officials, jointly prepared the objectives and exam questions for this subclass.

February 2016: Objectives 1.1.3, 3.1.3, and 3.1.12 were updated to reflect the revised total coliform rule that takes effect April 1, 2016.

February 2015: The reference list was updated.

January 2013 Revisions: The December 2006 edition of this study guide has been updated to reflect recent changes in bacteriological sampling requirements, fluoride concentration targets, and the disinfection by-products stage 2 rule. The following objectives have been updated: 3.1.9, 3.1.12, 3.1.15, 3.1.30, and 4.1.2.

How to Use This Study Guide with References

In preparation for the exam you should:

1. Read all the objectives and write down the answers to the objectives that readily come to mind.
2. Use the resources at the end of the study guide to look-up those answers you are not sure of.
3. Write down the answers found in the resources to those objectives you could not answer from memory.
4. Review all answered objectives until you can answer each from memory.

It is advisable that the operator take classroom or online training in this process before attempting the certification exam.

Choosing a Test Date

Before you choose a test date, consider the training opportunities available in your area. A listing of training opportunities and exam dates is available on the internet at <http://dnr.wi.gov>, keyword search "operator certification".

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Chapter 1 - Principle, Structure, and Function

Section 1.1 - Principles of Distribution

1.1.1 Describe the major components of a distribution system.

1.1.2 Discuss the reasons for metering water.

1.1.3 Define pathogenic and coliform bacteria.

1.1.4 State the water quality significance of the following:

1. pH
2. Oxygen
3. Manganese
4. Iron
5. Hardness
6. Alkalinity
7. Iron Bacteria
8. Natural Organic Matter (NOM)

Section 1.2 - Structure and Function

1.2.1 Define the following storage facilities:

- A. Stand Pipes
- B. Reservoirs
- C. Elevated Tanks

- 1.2.2 Describe the functions that elevated water storage serves in a distribution system.
- 1.2.3 Discuss the properties of the following types of pipe:
- A. Ductile Iron
 - B. Cast Iron
 - C. Asbestos Cement
 - D. Plastic (PVC)
 - E. Steel
 - F. Reinforced Concrete
- 1.2.4 Identify the different types of valves used in a distribution system.
- 1.2.5 Describe the operation and use of a gate valve.
- 1.2.6 Describe the operation and use of a butterfly valve.
- 1.2.7 Identify the different types of pumps used in a distribution system.

1.2.8 Describe the function of the following parts of a centrifugal pump:

1. Impeller
2. Shaft
3. Sleeves
4. Bearings
5. Lantern Ring
6. Mechanical Seal
7. Pump Casing
8. Packing
9. Packing Gland
10. Volute

1.2.9 Sketch a diagram of a centrifugal pump and label the parts.

1.2.10 Describe how a centrifugal pump works.

1.2.11 List and describe the function of the basic elements of a fire hydrant.

1.2.12 Sketch a typical service from the main to a customer's meter and label the parts.

1.2.13 List the types of meters used in a distribution system.

1.2.14 Sketch a diagram of a positive displacement meter and label the parts.

1.2.15 Identify locations where thrust blocks and tie rods should be used.

Chapter 2 - Operation and Maintenance

Section 2.1 - Operation

2.1.1 List the pressure standards for:

1. Minimum Fire Flow Pressure
2. Minimum Static
3. Maximum Static

2.1.2 Explain the accepted water main installation procedures with respect to the following:

- A. Unloading Pipe
- B. Storage of Pipe
- C. Trenching
- D. Bedding

2.1.3 Explain the accepted water main installation procedures with respect to the following:

- A. Pipe Laying
- B. Backfilling
- C. Clean-up

- 2.1.4 Describe the procedures necessary before a new main is placed in service.
- 2.1.5 Describe the locations or angles recommended for tapping water mains.
- 2.1.6 List the procedural steps involved in tapping a water main under pressure using a tapping machine.
- 2.1.7 Explain why water mains are tapped under pressure.
- 2.1.8 Discuss the methods used to locate valves and mains.
- 2.1.9 Explain the use and importance of records in locating valves or mains.
- 2.1.10 Explain how to determine if a valve is open or closed.
- 2.1.11 Explain what happens if a valve is closed too fast.

- 2.1.12 Explain the difference between dry and wet barrel hydrants.
- 2.1.13 Discuss the accuracy and common usage of the following meters:
- A. Positive Displacement
 - B. Compound
 - C. Turbine
- 2.1.14 Discuss the factors which must be considered in selecting the correct meter size.
- 2.1.15 Discuss electrical continuity in relation to plastic water meters and the removal of a water meter (plastic or metal) from its setting.
- 2.1.16 Define the following terms:
- A. Cross-connection
 - B. Backflow
 - C. Back-siphonage
 - D. Backpressure
- 2.1.17 Describe the following ways of controlling cross-connections, and explain how each works and is applied.
- A. Air Gap
 - B. Reduced Pressure Principal Backflow Preventer
 - C. Double Check Valve

- 2.1.18 Describe the following ways of controlling cross-connections, and explain how each works and is applied.
- A. Vacuum Breaker
 - B. Barometric Loop

Section 2.2 - Maintenance

- 2.2.1 Describe the items of information to be recorded on a meter test card.
- 2.2.2 List the items of information to be recorded on a valve record card.
- 2.2.3 Discuss how often valves and hydrants should be operated.
- 2.2.4 List good operational and maintenance procedures in relation to:
- 1. Pump Priming
 - 2. Pump Packing
 - 3. Pump Bearings
 - 4. Pump Alignment
- 2.2.5 State how often cross-connection control devices need to be inspected or tested.

2.2.6 Describe two ways steel storage tanks can be protected from corrosion.

2.2.7 Identify two qualities required of paint that will be in contact with potable water.

Chapter 3 - Monitoring and Troubleshooting

Section 3.1 - Monitoring

3.1.1 Demonstrate the ability to correctly read different types of meter registers.

3.1.2 Explain what is involved in a meter test bench operation.

3.1.3 Describe the Maximum Contaminant Level (MCL) for E. coli and the total coliform treatment technique trigger.

3.1.4 State how the minimum number of routine monthly bacteriological samples for community water supply systems is determined.

3.1.5 Describe a good bacteriological sampling program.

- 3.1.6 Explain the ideal sampling point for bacteriological sampling sites.

- 3.1.7 List the types of faucets or taps from which bacteriological samples should not be collected.

- 3.1.8 Describe sample container requirements used in collecting bacteriological samples from the following:
 - A. Chlorinated Distribution Systems
 - B. Non-chlorinated Distribution Systems

- 3.1.9 State the holding time for bacteriological samples.

- 3.1.10 Identify a method of storing bacteriological samples that cannot be analyzed immediately.

- 3.1.11 Identify the laboratories in Wisconsin where bacteriological samples may be analyzed.

- 3.1.12 Describe the procedure to follow when a bacteriological sample is positive.

- 3.1.13 State how many bacteriological samples must be collected after a reservoir has been cleaned or repaired, before it is put back into service.

- 3.1.14 Identify the laboratory tests where DPD and SPADNS chemicals are used.

- 3.1.15 Identify the range in which the fluoride concentration should be maintained.

- 3.1.16 Identify the maximum contaminant level (MCL) for fluoride.

- 3.1.17 State how often samples must be sent to the state laboratory of hygiene for fluoride analysis.

- 3.1.18 Specify how often an operator must test for fluoride if fluoride is being added to the water.

- 3.1.19 Identify the sample container requirements used in collecting fluoride samples.

- 3.1.20 Describe the fluoride test procedure utilizing the SPADNS method.

- 3.1.21 Define minimum chlorination residuals for water systems required to disinfect.

- 3.1.22 State how often an operator must test the chlorine residual in a distribution system if chlorine is being added.

- 3.1.23 Describe the free chlorine test procedure utilizing the DPD Method.

- 3.1.24 Describe the free chlorine test procedure utilizing the DPD method. [Continued from question 23.]

- 3.1.25 Explain the term maximum residual disinfectant level (MRDL) and list the MRDL for chlorine and chloramines.

- 3.1.26 Explain the correct way to read a water level meniscus in a piece of volumetric laboratory glassware.

- 3.1.27 Describe how to run a pH test using a pH meter.

- 3.1.28 Discuss the various methods used to determine the stability of water with respect to calcium carbonate saturation.

- 3.1.29 Describe the calculations involved in using the Langelier Index and the Calcium Carbonate Solubility Curve in determining corrosive or depositing properties of a particular water.

- 3.1.30 Identify where samples are collected for analysis of the disinfection byproducts trihalomethanes (TTHMs) and haloacetic acids (HAA5s) under the DBP Stage 2 rule, and list the MCLs.

Section 3.2 - Troubleshooting

- 3.2.1 Determine the cause and solution for the following water quality problems:
 - A. Rusty Water
 - B. Slime in Water Mains
 - C. Unsafe Samples
 - D. Stale Tasting Water
 - E. Rotten Egg Odor

- 3.2.2 Identify possible causes for the following pipe problems:
 - A. Joint Leaks
 - B. Blow Outs
 - C. Horizontal Cracks

- 3.2.3 Identify methods of leak detection.
- 3.2.4 Discuss how a main break can be isolated on a distribution system so the fewest possible customers are affected.
- 3.2.5 Identify ways to stop water flow in a copper service so a leaking curb stop can be fixed.
- 3.2.6 List the possible causes for the following pump problems:
- A. Short Bearing Life
 - B. Cavitation
 - C. Short Packing Life
 - D. Vibration
 - E. Loss of Prime
 - F. Reduced Rate of Discharge
 - G. Will not Start
- 3.2.7 Describe the symptoms of cavitation and old packing in pumps.
- 3.2.8 Identify the conditions that can cause back siphonage and backpressure.
- 3.2.9 Describe problems and remedies for low and high water pressure.

- 3.2.10 Identify possible causes and solutions for loss of system pressure.

- 3.2.11 Describe the procedures to be followed when distribution system pressure is lost in 25% or more of the system.

- 3.2.12 Explain the need and methods of maintaining electrical continuity when thawing frozen metallic pipe.

- 3.2.13 Explain how to thaw non-metallic services.

- 3.2.14 Explain how to thaw metallic water services.

Chapter 4 - Safety and Calculations

Section 4.1 - Safety

- 4.1.1 Describe the procedure to follow for safe trench shoring.

- 4.1.2 Identify which government agencies have regulations related to safe trenching practices.

Section 4.2 - Calculations

- 4.2.1 Convert the following: GPM figures to MGD, cubic feet to gallons, and gallons to cubic feet.

- 4.2.2 Given data, calculate the pounds of chlorine needed to disinfect a reservoir or section of pipe.

- 4.2.3 Given the height of water in an elevated storage tank, calculate the static pressure.

- 4.2.4 Given data, calculate the arithmetic average.

References and Resources

1. WATER DISTRIBUTION SYSTEM OPERATION AND MAINTENANCE

5th Edition (2005). Kenneth D. Kerri. California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.

<http://www.owp.csus.edu/courses/drinking-water.php> or available through inter-library loan at <http://aqua.wisc.edu/waterlibrary/>

2. BASIC SMALL WATER SYSTEM OPERATIONS

5th Edition (2009) Kenneth D. Kerri. California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.

<http://www.owp.csus.edu/courses/drinking-water.php> or available through inter-library loan at <http://aqua.wisc.edu/waterlibrary/>

3. WI ADMINISTRATIVE CODES NR 809, NR 810 and NR 811

Chapter NR 809: Safe drinking water

Chapter NR 810: Requirements for the operation and maintenance of public water systems

Chapter NR 811: Requirements for the operation and design of community water systems

Wisconsin Legislative Reference Bureau (608) 266-0341

<http://docs.legis.wisconsin.gov>

4. SAFE DRINKING WATER ACT

US EPA. EPA 816-F-04-030, (June 2004).

<http://water.epa.gov/lawsregs/rulesregs/sdwa/>

5. STAGE 1 DISINFECTANT AND DISINFECTION BYPRODUCT RULE (December 1998 and January 2001)

Complying with the Stage 1 Disinfectants and Disinfection Byproducts Rule: Basic Guide (March 2006) -- linked in the "Guidance" section

<http://water.epa.gov/lawsregs/rulesregs/sdwa/stage1/>

6. STAGE 2 DISINFECTANT AND DISINFECTION BYPRODUCT RULE (January 2006)

<http://water.epa.gov/lawsregs/rulesregs/sdwa/stage2/index.cfm>

Complying with the Stage 2 Disinfectant and Disinfection Byproducts Rule: Small Entity Compliance Guide (February 2007) -- linked from the "Compliance Help" web site

<http://water.epa.gov/lawsregs/rulesregs/sdwa/stage2/compliance.cfm>

7. CROSS CONNECTION CONTROL MANUAL

US EPA. EPA 816-R-03-002, (February 2003).

http://water.epa.gov/infrastructure/drinkingwater/pws/crossconnectioncontrol/crossconnection_control_manual.cfm

8. WATER DISTRIBUTION OPERATOR TRAINING HANDBOOK

4th edition, 2013: Lauer, William. Publisher: AWWA

<http://www.awwa.org> or available through inter-library loan at

<http://www.aqua.wisc.edu/Waterlibrary/>

9. WATER DISTRIBUTION SYSTEM MONITORING: A PRACTICAL APPROACH FOR EVALUATING DRINKING WATER QUALITY

Cantor, Abigail E. 2009. CRC Press, Boca Raton. 203 pp.

10. REVISED GUIDANCE MANUAL FOR SELECTING LEAD AND COPPER CONTROL STRATEGIES (March 2003)

US EPA, EPA 816-R-03-001

Available from the Compliance Help section of EPA's web site on the Lead and Copper Rule

<http://water.epa.gov/lawsregs/rulesregs/sdwa/lcr/compliancehelp.cfm>

11. STANDARD METHODS FOR THE EXAMINATION OF WATER & WASTEWATER

22nd Edition (2012). Joint Publication of: American Public Health Association, American Water Works Association, and Water Environment Federation

(Old WPCF). Publication Office: American Public Health Association, 1015 Fifteenth Street NW, Washington, DC 20005.

<http://www.standardmethods.org/> or available through most libraries

12. BASIC MANAGEMENT PRINCIPLES FOR SMALL WATER SYSTEMS.

AWWA No. 20222 (1982). American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone: (303) 794-7711.

<http://www.awwa.org>

13. DISTRIBUTION SYSTEM MAINTENANCE TECHNIQUES.

AWWA No. 20237 (1987). American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone: (303) 794-7711.

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14. LEAKS IN WATER DISTRIBUTION SYSTEMS.

AWWA No. 20236 (1987). American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone: (303) 794-7711.

<http://www.awwa.org>

15. MAINTAINING DISTRIBUTION-SYSTEM WATER QUALITY.

AWWA No. 20231 (1985). American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone: (303) 794-7711.

<http://www.awwa.org>

16. MAINTENANCE MANAGEMENT FOR WATER UTILITIES.

3rd Edition (2010). James K. Jordan. American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone: (303) 794-7711.

<http://www.awwa.org>

17. PLAIN TALK ABOUT DRINKING WATER.

5th Edition (2010/2009) James M. Symons. American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone: (303) 794-7711.

<http://www.awwa.org>

18. PUBLIC INFORMATION - HOW TO BUILD A SUCCESSFUL PUBLIC INFORMATION/PUBLIC RELATIONS PROGRAM.

AWWA No. 20242 (1989). American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone: (303) 794-7711.

<http://www.awwa.org>