OVERVIEW

• Introduction

• Expectations/Conditions of Each Class of License

• Technical Content per the ABC Need-to-Know Criteria
MAINE WATER OPERATOR CLASSIFICATION
(90-429 C.M.R. CHAPTER 1)

• Five Classifications
  • Very Small Water System (VSWS)
  • Class I
  • Class II
  • Class III
  • Class IV

• Two Disciplines (in Classes I to IV)
  • Treatment
  • Distribution

• Two Types of Classification
  • Full Licensure
  • Operator-in-Training (OIT)
CONDITIONS OF EMPLOYMENT

• Licensing – 3 E’s (Education, Experience, Examination)
  • Mandatory, Voluntary
  • Full Licensure, Operator-in-Training, Operator in Responsible Charge

• Education – Primary and Continuing
  • Minimum for Consideration: GED, High School
  • Trade Group & College Programs Exist
  • Education can be used in Place of Experience

• Experience – Direct or Related (1:2)
  • Summer Worker
  • Intern/Apprentice
  • Military
  • Industry

• Examination – Sequential or Direct-Entry
CONDITIONS OF EMPLOYMENT

• Skill Sets – One, Some, All
  • Mechanical – Construction, Operations, Maintenance
  • Science – Biology, Chemistry, Hydraulics, Hydrology
  • Math
  • Communication – Verbal and Written
  • Management & Leadership
  • Laboratory
  • Technology – Computers, PLCs
OPPORTUNITIES FOR EMPLOYMENT

Operations and Management

- Treatment Systems Operators
- Distribution Systems Operators
- Superintendent/General Manager
- Technical Support Staff

Administrative Staff
Maintenance Staff
Laboratory Staff
Construction Crew

Engineering Staff
EXPECTATIONS & CONDITIONS

VSWS: Six months direct or 1 year related experience

50 question exam
Basic Operations
Limited Management
6 TCHs per 2 Years

Class I: 1 year direct or 2 years related experience

100 question exam
Entry-level Operations
No Management
12 TCHs per 2 Years
EXPECTATIONS & CONDITIONS

Class II: 2 years direct or 4 years related experience

100 question exam

Basic Operations

Little to No Management

18 TCHs per 2 Years
EXPECTATIONS & CONDITIONS

Class III: 3 years direct or 6 years related experience

100 question exam

Advanced/Senior Operations

Some Management

24 TCHs per 2 Years
EXPECTATIONS & CONDITIONS

Class IV: 4 years direct or 8 years related experience

100 question exam

Advanced Operations

Senior Management

24 TCHs per 2 Years
Three Types of Questions per Topic

• Recall

• Application

• Analysis

As Class Level Increases, Fewer Recall Questions, More Analysis Questions (in general)

As Class Level Increases, Fewer Basic Questions, More Intermediate & Advanced Questions
TECHNICAL CONTENT

Treatment Process (T)

• Disinfection
• Chemical Dose Calculations (Pounds Formula)
• Filtration & Associated Processes
• Chemical Handling & Storage
• SCADA
• Troubleshooting & Process Adjustments

(30 – 12, 18, 0; 31 – 8,17, 6; 30 – 5, 18, 7; 33 – 5, 19, 9)
TECHNICAL CONTENT

Laboratory Analysis (T)

• Water Sample Analysis
• Sample Collection & Preservation
• Equipment – Use, Calibration, Maintenance
• Data Interpretation

(13 – 5, 8, 0; 14 – 5, 8, 1; 13 – 3, 7, 3; 13 – 3, 7, 3)
TECHNICAL CONTENT

Equipment O&M (T & D) & Installation (D)

- Pumps & Motors
- Meters & Sensors
- SOPs – Start Up/Shut Down, PM
- Chemical Feed
- Water Storage
- Piping – water, chemical, air

T - (27 – 11, 16, 0; 24 – 7, 15, 2; 23 – 5, 13, 5; 21 – 4, 11, 6)
D - (24 – 10, 14, 0; 24 – 10, 13, 1; 24 – 10, 12, 2; 25 – 10, 13, 2)
TECHNICAL CONTENT

Source Water Characteristics (T)

- Biological
- Chemical
- Physical
- Well Hydraulics
- Source Water Protection
- Inspections – Sanitary Surveys

(10 – 4, 6, 0; 11 – 2, 7, 2; 10 – 2, 6, 2; 9 – 2, 5, 2)
TECHNICAL CONTENT

Security, Safety, & Administrative Procedures (T & D), Compliance (T), and Interacting with the Public (D)

- Confined Space Entry
- Budgeting
- Emergency Planning
- Regulatory Compliance
- Asset Management
- Develop and Maintain SOPs
- Maintain System Records

T - (20 – 9, 11, 0; 20 – 9, 11, 0; 24 – 7, 12, 5; 24 – 6, 9, 9)
D - (24 – 10, 14, 0; 24 – 9, 14, 1; 23 – 7, 14, 2; 25 – 5, 15, 5)
TECHNICAL CONTENT

Distribution System Components (D)

- Pipes, Fittings, & Appurtenances - Maintenance
- Water Distribution System Design
- Backflow Prevention
- Water Volume & Flow
- Water Distribution System Pressure
- Distribution System Maps & Schematics

(25 – 10, 15, 0; 26 – 10, 16, 0; 26 – 5, 16, 5; 25 – 5, 15, 5)
TECHNICAL CONTENT

Disinfection Monitoring, Evaluation, Adjustment, & Laboratory Analysis/Interpretation (D)

- Dosage Adjustment
- Sample Collection & Testing
- Chlorine Residual
- Lead & Copper
- Disinfection By-Products

D - (27 – 19, 8, 0; 26 – 18, 8, 0; 27 – 11, 14, 2; 25 – 10, 13, 2)
Further Research to Help Prepare

- Association of Boards of Certification (ABC) Need-to-Know Criteria (8 documents – 4 for treatment, 4 for distribution)
- ABC Formula/Conversion sheets
- www.abccert.org
Recall – tasks at this level typically require the simple recall or recognition of specific facts, concepts, processes, or procedures, with little to no problem-solving involved. You may be asked to identify, illustrate, recall, and/or recognize specific information.

Application – tasks at this level will involve some basic problem solving, calculations, or the interpretation and application of data. You may be asked to calculate, categorize, classify, compare, differentiate, explain, specify, translate, and/or apply knowledge.

Analysis – tasks at this level may involve higher level problem solving, evaluation, or the fitting together of a variety of elements into a meaningful whole; they usually require many steps in the thought process. You may be asked to analyze, evaluate, formulate, generalize, judge, predict, and/or use inductive or deductive reasoning to arrive at a solution.

### Exam Content Outline

<table>
<thead>
<tr>
<th>Number of Questions</th>
<th>Content Area</th>
<th>Job Task Complexity Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>Treatment Process</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>14</td>
<td>Laboratory Analysis</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>24</td>
<td>Equipment Operation &amp; Maintenance</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>11</td>
<td>Source Water Characteristics</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>20</td>
<td>Security, Safety, Compliance, &amp; Administrative Procedures</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>100</td>
<td>Total</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>58</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
</tr>
</tbody>
</table>

*Your exam may contain up to 10 extra unscored pre-test questions (see Before You Dive In for more details).
Basic – A fundamental or lower level of knowledge is required. Operators performing tasks requiring this level of knowledge will be able to do so with some training; this level of knowledge may also be acquired and developed through job experience. Such tasks may be routine, utilizing established procedures, and have a low level of complexity. Not having this level of knowledge will have minimal impact or significance on the performance of the tasks listed in the Content Area, or on public safety and welfare.

Intermediate – A level of knowledge beyond the basic level is required. Operators performing tasks requiring this level of knowledge will be able to do so with training beyond that of the basic level. The operator will not only be able to apply required fundamental concepts, but will be able to understand and discuss the application and implications of changes to processes, policies, and procedures within the Content Area. Not having this level of knowledge will have a significant impact on the performance of the job and on public safety and welfare.

Advanced – A very high level of knowledge/job expertise is required and the operator will be functioning at an expert level. The operator can apply all fundamental, as well as highly developed or complex concepts, and will be able to design, review, and evaluate processes, policies, and procedures within the Content Area. Not having this level of knowledge will have a serious impact on the performance of the job and will be very harmful to public safety and welfare.

<table>
<thead>
<tr>
<th>Supporting Knowledge Type</th>
<th>Treatment Process (31%)*</th>
<th>Laboratory Analysis (14%)*</th>
<th>Equipment Operation &amp; Maintenance (24%)*</th>
<th>Source Water Characteristics (17%)*</th>
<th>Security, Safety, Compliance &amp; Administrative Procedures (29%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arithmetic (e.g., measurements and calculations)</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Biology (e.g., pathogenic organisms)</td>
<td>Basic</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Chemistry (e.g., water chemistry)</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Chemical dosing (coagulants, oxidants, disinfectants, acids and bases)</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Chemical feed equipment (e.g., liquid, solid, gases)</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Chemical properties (e.g., reactivity, compatibility, pH)</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Contaminants (e.g., organic, inorganic)</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Disciplinary procedures</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>General electrical principles (e.g., troubleshooting, breakers, relays, circuits)</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Internal combustion engines</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Laboratory equipment (e.g., glassware)</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Laboratory instrumentation (e.g., operation, and calibration)</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td></td>
</tr>
</tbody>
</table>
### Formula/Conversion Table

**Water Treatment, Distribution, & Water Laboratory Exams**

**Alkalinity, mg/L as CaCO₃**
\[
\text{Alkalinity, mg/L as CaCO}_3 = \frac{\text{Titrant Volume, mL}(\text{Acid Normality})(50,000)}{\text{Sample Volume, mL}}
\]

**Amps**
\[
\text{Amps} = \frac{\text{Volts}}{\text{Ohms}}
\]

**Area of Circle**
\[
\text{Area of Circle}^* = (0.785)(\text{Diameter}^2)
\]

**Area of Circle**
\[
\text{Area of Circle} = (3.14)(\text{Radius}^2)
\]

**Area of Cone (lateral area)**
\[
\text{Area of Cone (lateral area)} = (3.14)(\text{Radius})\sqrt{\text{Radius}^2 + \text{Height}^2}
\]

**Area of Cone (total surface area)**
\[
\text{Area of Cone (total surface area)} = (3.14)(\text{Radius})(\text{Radius} + \sqrt{\text{Radius}^2 + \text{Height}^2})
\]

**Area of Cylinder (total exterior surface area)**
\[
\text{Area of Cylinder (total exterior surface area)} = [\text{End #1 SA}] + [\text{End #2 SA}] + [(3.14)(\text{Diameter})(\text{Height or Depth})]
\]

*Where SA = surface area*

**Area of Rectangle**
\[
\text{Area of Rectangle}^* = (\text{Length})(\text{Width})
\]

**Area of Right Triangle**
\[
\text{Area of Right Triangle}^* = \frac{(\text{Base})(\text{Height})}{2}
\]

**Average (arithmetic mean)**
\[
\text{Average (arithmetic mean)} = \frac{\text{Sum of All Terms}}{\text{Number of Terms}}
\]
Conversion Factors

1 acre = 43,560 ft² = 4,046.9 m²
1 acre foot of water = 326,000 gal
1 cubic foot of water = 7.48 gal = 62.4 lb
1 cubic foot per second = 0.646 MGD = 448.8 gpm
1 cubic meter of water = 1,000 kg = 1,000 L = 264 gal
1 foot = 0.305 m
1 foot of water = 0.433 psi
1 gallon (US) = 3.785 L = 8.34 lb of water
1 grain per US gallon = 17.1 mg/L
1 hectare = 10,000 m²
1 horsepower = 0.746 kW = 746 W = 33,000 ft lb/min
1 inch = 2.54 cm
1 liter per second = 0.0864 MLD
1 meter of water = 9.8 kPa
1 metric ton = 2,205 lb = 1,000 kg
1 mile = 5,280 ft = 1.61 km
1 million US gallons per day = 694 gpm = 1.55 ft²/sec
1 pound = 0.454 kg
1 pound per square inch = 2.31 ft of water
1 square meter = 1.19 yd²
1 ton = 2,000 lb
1% = 10,000 mg/L
π or pi = 3.14

Alkalinity Relationships

All Alkalinity expressed as mg/L as CaCO₃ • P = phenolphthalein alkalinity • T = total alkalinity

<table>
<thead>
<tr>
<th>Result of Titration</th>
<th>Hydroxide Alkalinity</th>
<th>Carbonate Alkalinity</th>
<th>Bicarbonate Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>P = 0</td>
<td>0</td>
<td>0</td>
<td>T</td>
</tr>
<tr>
<td>P &lt; ½T</td>
<td>0</td>
<td>2P</td>
<td>T − 2P</td>
</tr>
<tr>
<td>P = ½T</td>
<td>0</td>
<td>2P</td>
<td>0</td>
</tr>
<tr>
<td>P &gt; ½T</td>
<td>2P − T</td>
<td>2(T − P)</td>
<td>0</td>
</tr>
<tr>
<td>P = T</td>
<td>T</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Pie Wheel Format for this equation is available at the end of this document

Copyright © 2017 by Association of Boards of Certification

Water Treatment, Distribution, Laboratory Formula/Conversion Table - Page 6 of 7
2. Determine if the following integrals converge or diverge:

(a) \[
\int_{1}^{\infty} \frac{7 \cos^2(x)}{3 + x^2} \, dx
\]

(b) \[
\int_{0}^{\pi/2} \frac{2}{x \sin(x)} \, dx
\]

(c) \[
\int_{1}^{\infty} \frac{2}{\sqrt{4x^2 - 2}} \, dx
\]