ABC Need-to-Know Criteria for Water Treatment Operators

ABC
Association of Boards of Certification

2805 SW Snyder Blvd., Suite 535, Ankeny, Iowa 50023
Phone (515) 232-3623 Fax (515) 965-6827
Email abc@abccert.org Website www.abccert.org

Introduction

As part of the development of its certification exams, the Association of Boards of Certification (ABC) conducted a job analysis of water treatment operators during 1980 and 1981. The purpose of the job analysis was to identify the essential job tasks performed by water treatment operators and the capabilities required to competently perform these job tasks. The results of this job analysis provided ABC with the foundation for the development of valid water treatment certification exams. These exams were offered by ABC for the first time in 1982.

ABC periodically re-evaluates the need-to-know criteria to ensure it reflects current technology. Our most recent evaluation was conducted in 2006 when ABC conducted a national survey of water treatment operators. This Need-to-Know Criteria was developed from the results of the 2006 job analysis and will be used to determine the content of the ABC water treatment certification exams administered beginning in January 2008.

The information in this document reflects the essential job tasks performed by operators and their requisite capabilities. This document is intended to be used by certification programs and trainers to help prepare operators for certification in the profession.

How the Need-to-Know Criteria was Developed

Task Survey

ABC's Water Treatment Validation and Examination Committee provided technical assistance throughout the job analysis process. This committee worked with ABC staff to develop the national job task survey. 501 certified water treatment operators throughout the United States and Canada were invited to complete the survey. 173 surveys were completed for a response rate of 35%. 11% of the respondents were class I operators, 30% were class II operators, 28% were class III operators, and 31% were class IV operators.

In this survey, certified operators were asked to rate job tasks and capabilities on rating scales for frequency of performance and seriousness of inadequate or incorrect performance. These two rating scales were used because they provide useful information (i.e., how critical each task is and how frequently each task is performed) pertaining to certification. The survey also included a background information section where demographic data such as gender, age, ethnic origin, educational level attained, work experience, and certification level were collected. Space was provided at the end of the survey for operators to list any important tasks performed on their job which were not included on the survey and to make general comments.

Survey Results

The mean, standard deviation, and the percentage of respondents performing each task statement were computed. The mean was used to determine the importance of items and the standard deviation was used to identify items with a wide variation in responses. The percentage of respondents performing each task statement was used to identify tasks and capabilities commonly performed by operators throughout the United States and Canada.

A criticality value of 2(mean seriousness rating) + mean frequency rating was calculated for each item on the survey. This formula gives extra weight to the seriousness rating in determining critical items and was appropriate because it emphasized the purpose of certification—to provide competent operators.

Core Competencies

The ABC Water Treatment Validation and Examination Committee reviewed the results of the task survey to identify the most important and commonly performed job tasks and capabilities for water treatment operators. Tasks and their requisite capabilities performed by at least 50% of the respondents and with a high criticality value were designated as core competencies. They were the most important and commonly performed job tasks and capabilities.

The core competencies were considered the essential tasks and capabilities for water treatment operators. The core competencies are clustered into the following job duties:

- Monitor, Evaluate and Adjust Treatment Processes
- Laboratory Analysis
- Evaluate Characteristics of Source Water
- Comply with Drinking Water Regulations
- Operate and Maintain Equipment
- Perform Security, Safety and Administrative Procedures

The level of knowledge (i.e., comprehension, application, analysis) required for each task is also identified in the following pages.

- **Comprehension** is the most basic level of understanding and remembering. Items written at the comprehension level require examinees to recognize, remember, or identify important ideas.
- Items written at the **application** level require examinees to interpret, calculate, predict, use or apply information and solve problems.
- Items written at the **analysis** level require examinees to compare, contrast, diagnose, examine, analyze, and relate important concepts.

The level of knowledge is a hierarchy from basic comprehension to analysis. The level of knowledge tested is cumulative. Therefore, tasks identified as application may include questions written at both the application and comprehension levels. Tasks identified as analysis may include questions written at the comprehension, application and analysis levels.

Core Competencies for Water Treatment Operators

Monitor, Evaluate and Adjust Treatment Processes	Class Level			
	I	II	III	IV
Source Water Treatment				
Algae control	Comprehension	Application	Application	Analysis
Chemical treatment (copper sulfate)	Comprehension	Application	Application	Analysis
Intake structure/wellhead	Comprehension	Comprehension	Application	Analysis
Chemical Treatment/Addition				
Taste and odor control	Comprehension	Application	Application	Analysis
Fluoridation	Comprehension	Analysis	Analysis	Analysis
Chlorine disinfection	Analysis	Analysis	Analysis	Analysis
Chlorine dioxide disinfection	Comprehension	Comprehension	Application	Application
Chloramination	Comprehension	Comprehension	Application	Application
Ozone disinfection		Comprehension	Application	Application
Ultraviolet disinfection	Comprehension	Comprehension	Application	Application
pH adjustment for process control	Comprehension	Application	Analysis	Analysis
pH adjustment for corrosion control	Application	Application	Analysis	Analysis
Corrosion control	Comprehension	Comprehension	Application	Analysis
Potassium permanganate	Application	Analysis	Analysis	Analysis
Coagulation and Flocculation				
Chemical coagulants	Comprehension	Application	Application	Analysis
Rapid mix units	Comprehension	Application	Application	Analysis
Flocculation tanks/basins	Comprehension	Application	Application	Analysis
Clarification/Sedimentation				
Sedimentation basins	Comprehension	Application	Application	Analysis
Upflow solids-contact clarification	Comprehension	Comprehension	Application	Analysis
Inclined-plate sedimentation		Comprehension	Application	Analysis
Tube settlers/high-rate		Comprehension	Application	Analysis
Dissolved air flotation		Comprehension	Application	Analysis
Other clarification/sedimentation		Comprehension	Application	Analysis
Filtration				
Gravity/rapid sand filtration	Comprehension	Application	Application	Analysis
Membrane filtration (MF, UF, NF)	Comprehension	Comprehension	Comprehension	Application
Reverse osmosis	Comprehension	Comprehension	Application	Analysis
Electrodialysis		Comprehension	Comprehension	Comprehension
Cartridge filters	Comprehension	Application	Application	Application
Slow sand filters	Comprehension	Application	Application	Analysis
Pressure or greensand filtration	Application	Application	Application	Application

(continued)

Core Competencies (continued)

Monitor, Evaluate and Adjust Treatment Processes (continued)	Class Level			
	I	II	III	IV
Other Treatment Processes				
Aeration	Comprehension	Application	Application	Analysis
Packed tower aeration		Comprehension	Comprehension	Comprehension
Ion exchange softening	Comprehension	Comprehension	Comprehension	Comprehension
Iron and manganese sequestration/removal	Application	Application	Application	Application
Lime-soda ash softening	Comprehension	Comprehension	Application	Analysis
Granular activated carbon		Comprehension	Comprehension	Application
Powdered activated carbon		Comprehension	Comprehension	Application
Coagulation aids	Comprehension	Application	Application	Analysis
Filter aids		Application	Application	Analysis
Backwash aids		Application	Application	Analysis
Residuals Disposal				
Backwash water/supernatant	Comprehension	Comprehension	Application	Analysis
Deep well injection		Comprehension	Comprehension	Comprehension
Discharge to lagoons and then surface water		Comprehension	Comprehension	Comprehension
Discharge to sewers	Comprehension	Comprehension	Comprehension	Comprehension
Drying beds/evaporation ponds		Comprehension	Comprehension	Comprehension
Land application		Comprehension	Comprehension	Comprehension
Mechanical dewatering		Comprehension	Application	Analysis

Job Tasks Required for Treatment Processes

- Adjust chemical feed rates
- Adjust flow patterns
- Adjust process units
- Calculate dosage rates
- Confirm chemical strength
- Diagnose/troubleshoot process units
- Measure chemical weight/volume
- Monitor and evaluate process units
- Perform basic math
- Perform physical measurements
- Perform process control calculations
- Prepare chemicals

Capabilities Required for Treatment Processes

- Ability to maintain processes in normal operating condition
- Knowledge of chemical application procedures
- Knowledge of chemical handling and storage procedures
- Knowledge of chemical properties
- Knowledge of general biology and chemistry
- Knowledge of general electrical principles
- Knowledge of hydraulic principles
- Knowledge of math concepts
- Knowledge of normal chemical range
- Knowledge of physical science
- Knowledge of principles of measurement
- Knowledge of treatment concepts and processes
- Knowledge of water treatment design parameters

Core Competencies (continued)

Laboratory Analysis	Class Level			
	I	II	III	IV
Collect Samples				
Alkalinity	Comprehension	Application	Application	Application
Carbon dioxide			Comprehension	Comprehension
Chlorine demand	Analysis	Analysis	Analysis	Analysis
Chlorine residual	Analysis	Analysis	Analysis	Analysis
Conductivity			Comprehension	Comprehension
Cryptosporidium	Comprehension	Comprehension	Comprehension	Comprehension
Disinfectant by-products (THM)	Comprehension	Comprehension	Comprehension	Comprehension
Dissolved oxygen	Comprehension	Comprehension	Comprehension	Comprehension
Fluoride concentration	Comprehension	Application	Application	Application
Giardia lamblia	Comprehension	Comprehension	Comprehension	Comprehension
Hardness	Comprehension	Comprehension	Comprehension	Comprehension
Inorganic (heavy metal) chemical	Comprehension	Comprehension	Comprehension	Comprehension
Iron/manganese	Application	Application	Application	Application
Jar test	Comprehension	Comprehension	Comprehension	Comprehension
Lead/copper	Comprehension	Application	Application	Application
Microbiological	Application	Application	Application	Application
Nitrate	Comprehension	Comprehension	Comprehension	Comprehension
Ortho-polyphosphate	Comprehension	Comprehension	Comprehension	Comprehension
pH	Application	Application	Application	Application
Radiological parameters	Comprehension	Comprehension	Comprehension	Comprehension
Settleable solids		Comprehension	Comprehension	Comprehension
Synthetic organic chemicals	Comprehension	Comprehension	Comprehension	Comprehension
Taste and odor thresholds	Comprehension	Comprehension	Comprehension	Comprehension
Temperature	Application	Application	Application	Application
Turbidity	Analysis	Analysis	Analysis	Analysis
Total organic carbon (TOC)	Comprehension	Comprehension	Comprehension	Comprehension
Total suspended solids (TSS)			Comprehension	Comprehension
Volatile organic chemicals		Comprehension	Comprehension	Comprehension
Interpret Analysis				
Alkalinity	Comprehension	Comprehension	Comprehension	Comprehension
Carbon dioxide			Application	Application
Chlorine demand	Application	Application	Application	Application
Chlorine residual	Analysis	Analysis	Analysis	Analysis
Conductivity			Comprehension	Comprehension
Cryptosporidium	Comprehension	Comprehension	Comprehension	Comprehension
Disinfectant by-products (THM)	Comprehension	Comprehension	Comprehension	Comprehension
Dissolved oxygen	Comprehension	Comprehension	Comprehension	Comprehension

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Core Competencies (continued)

Laboratory Analysis (continued)	Class Level			
	I	II	III	IV
Fluoride concentration	Comprehension	Comprehension	Comprehension	Application
Giardia lamblia	Comprehension	Comprehension	Comprehension	Comprehension
Hardness	Comprehension	Comprehension	Comprehension	Comprehension
Inorganic (heavy metal) chemical	Comprehension	Comprehension	Comprehension	Comprehension
Iron/manganese	Comprehension	Comprehension	Comprehension	Comprehension
Jar test	Comprehension	Application	Application	Analysis
Lead/copper	Comprehension	Comprehension	Comprehension	Comprehension
Microbiological	Comprehension	Application	Application	Analysis
Nitrate	Comprehension	Comprehension	Comprehension	Comprehension
Ortho-polyphosphate	Comprehension	Comprehension	Application	Application
pH	Application	Application	Application	Application
Settleable solids		Comprehension	Comprehension	Comprehension
Taste and odor thresholds	Comprehension	Comprehension	Comprehension	Comprehension
Temperature	Comprehension	Comprehension	Comprehension	Comprehension
Turbidity	Analysis	Analysis	Analysis	Analysis
Total organic carbon (TOC)	Comprehension	Comprehension	Comprehension	Comprehension
Total suspended solids (TSS)			Comprehension	Comprehension
Volatile organic chemicals			Comprehension	Comprehension
Perform Plant Process Control Analysis				
Alkalinity	Comprehension	Application	Application	Application
Carbon dioxide			Comprehension	Comprehension
Chlorine demand	Application	Application	Application	Application
Chlorine residual	Analysis	Analysis	Analysis	Analysis
Conductivity			Comprehension	Comprehension
Dissolved oxygen			Comprehension	Comprehension
Fluoride concentration	Comprehension	Application	Application	Application
Hardness	Comprehension	Comprehension	Comprehension	Comprehension
Iron/manganese	Application	Application	Application	Application
Jar test	Comprehension	Application	Application	Analysis
Microbiological		Comprehension	Application	Application
Ortho-polyphosphate	Comprehension	Comprehension	Comprehension	Comprehension
pH	Application	Application	Application	Application
Settleable solids		Comprehension	Comprehension	Comprehension
Taste and odor thresholds	Comprehension	Comprehension	Comprehension	Comprehension
Temperature	Comprehension	Comprehension	Comprehension	Comprehension
Turbidity	Analysis	Analysis	Analysis	Analysis
Total suspended solids (TSS)			Comprehension	Comprehension

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Core Competencies (continued)

Job Tasks Required for Laboratory Analysis

- Analyze samples
- Calculate results of tests
- Calibrate lab instruments
- Check reagents
- Evaluate data
- Interpret test results
- Maintain log book
- Make reagents
- Measure and prepare chemicals
- Operate lab instruments
- Preserve, store, and ship samples
- Record samples
- Select proper test method
- Select sample locations and take samples
- Store and dispose of chemicals
- Summarize results of analysis

Capabilities Required for Laboratory Analysis

- Ability to recognize abnormal analytical results
- Knowledge of basic laboratory techniques
- Knowledge of chemical handling and storage procedures
- Knowledge of drinking water regulations
- Knowledge of general biology, chemistry and physical science
- Knowledge of laboratory equipment
- Knowledge of normal characteristics of water
- Knowledge of principles of measurement
- Knowledge of quality control/quality assurance practices
- Knowledge of sample containers
- Knowledge of sampling procedures
- Knowledge of *Standard Methods for the Examination of Water and Wastewater*

Evaluate Characteristics of Source Water	Class Level			
	I	II	III	IV
Bacteriological	Comprehension	Analysis	Analysis	Analysis
Biological	Comprehension	Comprehension	Comprehension	Comprehension
Chemical	Comprehension	Comprehension	Comprehension	Application
Physical	Comprehension	Comprehension	Comprehension	Application
Agriculture, recreation and industry impact	Comprehension	Comprehension	Comprehension	Comprehension
Groundwater conditions	Comprehension	Comprehension	Comprehension	Comprehension
Reservoir stratification		Comprehension	Comprehension	Comprehension
Stratification/turnover challenges	Comprehension	Comprehension	Comprehension	Comprehension

Capabilities Required to Evaluate Characteristics of Source Water

- Ability to communicate observations verbally and in writing
- Ability to recognize abnormal conditions
- Knowledge of hydrology
- Knowledge of normal characteristics of water
- Knowledge of sanitary survey process
- Knowledge of watershed protection/wellhead protection

Core Competencies (continued)

Comply with Drinking Water Regulations	Class Level			
	I	II	III	IV
United States Exams – Code of Federal Regulations, Title 40, Part 141 - National Primary Drinking Water Regulations				
Subpart A - General definitions	Comprehension	Comprehension	Comprehension	Comprehension
Subpart B - Maximum contaminant levels	Comprehension	Comprehension	Comprehension	Comprehension
Subpart C - Monitoring and analytical requirements	Comprehension	Comprehension	Comprehension	Comprehension
Subpart D - Reporting and recordkeeping	Comprehension	Comprehension	Comprehension	Comprehension
Subpart E - Special regulations	Comprehension	Comprehension	Comprehension	Comprehension
Subpart G - National revised primary drinking water regulations: maximum contaminant level and maximum residual disinfectant levels	Comprehension	Comprehension	Comprehension	Comprehension
Subpart H - Filtration and disinfection	Comprehension	Comprehension	Comprehension	Comprehension
Subpart I - Control of lead and copper	Comprehension	Comprehension	Comprehension	Comprehension
Subpart J - Use of non-centralized treatment devices	Comprehension	Comprehension	Comprehension	Comprehension
Subpart K - Treatment techniques	Comprehension	Comprehension	Comprehension	Comprehension
Subpart L - Disinfection residuals, disinfection byproducts, and disinfection byproduct precursors	Comprehension	Comprehension	Comprehension	Comprehension
Subpart O - Consumer confidence reports	Comprehension	Comprehension	Comprehension	Comprehension
Subpart P - Enhanced filtration and disinfection	Comprehension	Comprehension	Comprehension	Comprehension
Subpart Q - Public notification of drinking water violations	Comprehension	Comprehension	Comprehension	Comprehension
Canadian Exams				
Provincial and territorial regulations	Comprehension	Comprehension	Comprehension	Comprehension

Operate and Maintain Equipment	Class Level			
	I	II	III	IV
Operate Equipment				
Blowers, compressors and pneumatics	Comprehension	Application	Application	Application
Chemical feeders	Analysis	Analysis	Analysis	Analysis
Computers	Application	Application	Application	Application
Electronic testing equipment	Comprehension	Comprehension	Comprehension	Comprehension
Generators	Comprehension	Comprehension	Comprehension	Comprehension
Hydraulic equipment		Comprehension	Comprehension	Comprehension
Instrumentation	Application	Application	Application	Application
Intake structure/well	Application	Application	Application	Application
Prime movers/drives (engines and motors)	Application	Application	Application	Application
Valves	Application	Application	Application	Application
Water pumps	Analysis	Analysis	Analysis	Analysis

(continued)

Core Competencies (continued)

Operate and Maintain Equipment (continued)	Class Level			
	I	II	III	IV
Maintain Equipment				
Blowers, compressors and pneumatics	Comprehension	Application	Application	Application
Chemical feeders	Application	Application	Application	Application
Computers	Application	Application	Application	Application
Electronic testing equipment	Comprehension	Comprehension	Comprehension	Comprehension
Fittings	Comprehension	Comprehension	Comprehension	Comprehension
Generators	Comprehension	Comprehension	Comprehension	Comprehension
Hydraulic equipment		Comprehension	Comprehension	Comprehension
Instrumentation	Application	Application	Application	Application
Intake structure/well	Comprehension	Comprehension	Comprehension	Comprehension
Pipes	Comprehension	Comprehension	Comprehension	Comprehension
Prime movers/drives (engines and motors)	Comprehension	Comprehension	Comprehension	Comprehension
Valves	Comprehension	Comprehension	Comprehension	Comprehension
Water pumps	Application	Application	Application	Application
Water treatment filters	Comprehension	Application	Application	Application

Job Tasks Required to Operate and Maintain Equipment

- Calculate pump drawdown and pump efficiency
- Calibrate equipment
- Change oil/lubricate equipment
- Clean equipment
- Diagnose/troubleshoot equipment
- Evaluate and adjust equipment
- Interpret pump performance curves
- Maintain seals and bearings
- Monitor charts, meters and pressure gauges
- Perform cathodic protection
- Perform general maintenance
- Prime pumps
- Recognize potential backflow and cross-connection conditions
- Repack pumps
- Replace equipment
- Start up and shut down equipment
- Test for and repair leaks

Capabilities Required to Operate and Maintain Equipment

- Ability to differentiate between preventive and corrective maintenance
- Ability to discriminate between normal and abnormal operating conditions
- Knowledge of control systems
- Knowledge of drinking water treatment concepts
- Knowledge of facility operation and maintenance
- Knowledge of function of tools
- Knowledge of general electrical and mechanical principles
- Knowledge of hydraulic and pneumatic principles
- Knowledge of lubricant and fluid characteristics
- Knowledge of process control instrumentation

Core Competencies (continued)

Perform Security, Safety and Administrative Procedures	Class Level			
	I	II	III	IV
Follow safety procedures related to				
Chemical handling	Application	Analysis	Analysis	Analysis
Confined space entry	Analysis	Analysis	Analysis	Analysis
Electrical hazards	Application	Application	Application	Application
Facility upset	Application	Application	Application	Application
Fire safety	Application	Application	Application	Application
Lock-out/tag-out	Application	Application	Application	Application
Pathogens	Application	Application	Application	Application
Personal protective equipment	Analysis	Analysis	Analysis	Analysis
Safety equipment	Application	Application	Application	Application
Spill response	Application	Application	Application	Application
Perform administrative procedures, such as				
Administer compliance and laboratory programs	Comprehension	Comprehension	Comprehension	Comprehension
Administer emergency preparedness, safety and security programs	Comprehension	Comprehension	Comprehension	Comprehension
Assign work to proper trade	Comprehension	Comprehension	Comprehension	Comprehension
Conduct training	Comprehension	Comprehension	Comprehension	Comprehension
Develop budget	Comprehension	Comprehension	Comprehension	Comprehension
Develop operation and maintenance plan	Comprehension	Comprehension	Comprehension	Comprehension
Develop written policies and procedures	Comprehension	Comprehension	Comprehension	Comprehension
Direct quality control programs		Comprehension	Comprehension	Comprehension
Order supplies/equipment	Comprehension	Comprehension	Comprehension	Comprehension
Perform basic math	Application	Application	Application	Application
Plan and organize work activities	Comprehension	Comprehension	Comprehension	Comprehension
Record and evaluate data	Analysis	Analysis	Analysis	Analysis
Respond to complaints	Application	Application	Application	Application
Review reports	Comprehension	Comprehension	Comprehension	Comprehension
Write regulatory authority reports	Application	Application	Application	Application

Capabilities Required to Perform Security, Safety and Administrative Procedures

- Ability to assess likelihood of emergencies occurring
- Ability to recognize unsafe work conditions
- Ability to translate technical language into common terminology
- Knowledge of emergency plans
- Knowledge of information storage and recovery systems
- Knowledge of local codes and ordinances
- Knowledge of Material Safety Data Sheets
- Knowledge of monitoring and reporting requirements
- Knowledge of potential causes and impact of abnormal facility conditions
- Knowledge of principles of finance
- Knowledge of principles of management
- Knowledge of principles of public relations
- Knowledge of public administration practices
- Knowledge of recordkeeping function and policies
- Knowledge of regulations
- Knowledge of reporting responsibilities
- Knowledge of risk management

ABC Water Treatment Certification Exams

The ABC water treatment certification exams evaluate an operator's knowledge of tasks related to the operation of water treatment plants. The Water Treatment V&E Committee determined the content of each exam based on the results of the national job analysis. To pass an ABC exam, an operator must demonstrate knowledge of these core competencies. Because certificates may be used to work in various treatment plants, the exams may include technologies that are not used in each treatment plant but are commonly used in many treatment plants.

Four levels of certification exams are offered by ABC, with class I being the lowest level and class IV the highest level. The specifications for the exams are based on a weighting of the job analysis results so that they reflect the criticality of tasks performed on the job. The specifications list the percentage of questions on the exam that fall under each job duty. For example, 24% of the questions on the ABC class I exam relate to the job duty "Monitor, Evaluate and Adjust Treatment Processes." For a list of tasks and capabilities associated with each job duty, please refer to the list of core competencies on the previous pages.

ABC Water Treatment Exam Specifications

	Exam Level			
	Class I	Class II	Class III	Class IV
Monitor, Evaluate and Adjust Treatment Processes	24%	38%	43%	43%
Laboratory Analysis	16%	19%	16%	16%
Evaluate Characteristics of Source Water	5%	5%	5%	5%
Comply with Drinking Water Regulations	20%	15%	15%	15%
Operate and Maintain Equipment	24%	16%	15%	15%
Perform Security, Safety and Administrative Procedures	11%	7%	6%	6%

Suggested Water Treatment Exam References

The following are approved as reference sources for the ABC water treatment examinations. Operators should use the latest edition of these reference sources to prepare for the exam.

American Water Works Association (AWWA)

Principles and Practices of Water Supply Operations Series:
- *Water Sources*
- *Water Treatment*
- *Water Transmission and Distribution*
- *Water Quality*
- *Basic Science Concepts and Applications*

Other AWWA References:
- *Water Quality and Treatment*
- *Water System Security, A Field Guide*

To order, contact: American Water Works Association
6666 W Quincy Ave
Denver CO 80235

Web site: www.awwa.org
Phone: (800) 926-7337
Fax: (303) 347-0804
E-mail: custsvc@awwa.org

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Suggested Water Treatment Exam References *(continued)*

Association of State Drinking Water Administrators (ASDWA) and National Rural Water Association (NRWA)

• *Security Vulnerability Self Assessment Guide for Small Drinking Water Systems*

To order, contact: ASDWA
1401 Wilson Blvd Ste 1225
Arlington VA 22209

Web site: www.asdwa.org (available online in PDF format; select "Program Areas," then "Security," then "Training and Tools")
Phone: (703) 812-9505
Fax: (703) 812-9506
E-mail: info@asdwa.org

California State University, Sacramento (CSUS) Foundation, Office of Water Programs

• *Water Treatment Plant Operation*, Volumes I and II
• *Manage for Success*

To order, contact: Office of Water Programs
California State University, Sacramento
6000 J St
Sacramento CA 95819-6025

Web site: www.owp.csus.edu
Phone: (916) 278-6142
Fax: (916) 278-5959
E-mail: wateroffice@owp.csus.edu

Regulations

For United States exams:

- *Code of Federal Regulations*, Title 40, Part 141 (www.gpo.gov)
- State regulations (contact information for state certification programs is available on the Certification Contacts page of ABC's web site, www.abccert.org)

For Canadian exams:

- *Guidelines for Canadian Drinking Water Quality*. Federal-Provincial-Territorial Subcommittee on Drinking Water. Ottawa, ON: Health Canada (www.hc-sc.gc.ca/waterquality)
- Provincial and territorial regulations (contact information for provincial/territorial certification programs is available on the Certification Contacts page of ABC's web site, www.abccert.org)

Study Guides

American Water Works Association, *Operator Certification Study Guide: A Guide to Preparing for Water Treatment and Distribution Operator Certification Exams* (www.awwa.org; complete contact information is on preceding page)

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Introduction

As part of the development of its certification exams, the Association of Boards of Certification (ABC) conducted a job analysis of water laboratory analysts during 2001 and 2002. The purpose of the job analysis was to identify the essential job tasks performed by water laboratory analysts and the capabilities required to competently perform these job tasks. The results of this job analysis provide ABC with the foundation for the development of new water laboratory analyst certification exams.

The *Need-to-Know Criteria* was developed from the results of ABC's water laboratory job analysis. The information in this document reflects the essential job tasks performed by analysts and their requisite capabilities. This document is intended to be used by certification programs and trainers to help prepare analysts for certification.

How the Job Analysis was Conducted

Subject Matter Expert Committee

The ABC Water Laboratory Validation and Examination Committee provided technical assistance in the development of the job analysis. This committee developed the list of the important job tasks performed by water laboratory analysts. The committee verified the technical accuracy, clarity, and comprehensiveness of the job tasks. The committee then identified the capabilities (i.e., knowledge, skills, and abilities) required to perform the identified job tasks. Identification of capabilities was done on a task-by-task basis, so that a link was established between each task statement and requisite capability.

Task Survey

A task survey was developed from the data collected by the committee. The survey included 8-point rating scales for frequency of performance and seriousness of inadequate or incorrect performance. These two rating scales were used because they provide useful information (i.e., how critical each task is and how frequently each task is performed) pertaining to certification.

The task inventory also included a background information section where demographic data such as gender, age, ethnic origin, educational level attained, work experience, and certification level were collected. Space was provided at the end of the survey for analysts to list any important tasks performed on their job which were not included on the survey, and to make general comments.

The task inventory was sent to 299 water laboratory analysts throughout the United States. 153 out of the 299 inventories mailed were returned for a response rate of 51%. Class levels were created based on lab tests run as follows:

Class I: Non-supervisors running the following lab tests: pH, Chlorine residual, Temperature, TS/Dissolved solids, Hardness, Alkalinity, Turbidity, and Fluoride.

Class II: Non-supervisors running the following lab tests: all Class I tests plus Nitrogen, Phosphorus, Coliform, Heterotrophic plate count, Chloride, and Sulfate.

Class III: Non-supervisors running the following lab tests: all Class I and II tests plus Metals, Inorganics, Organics, and Microbiology of algae and water organisms.

Class IV: Supervisors running any of the tests listed above in Class I through III.

Results

The mean, standard deviation, and the percentage of respondents performing each task statement at each class level were computed. The mean was used to determine the importance of items and the standard deviation was used to identify items with a wide variation in responses. The percentage of respondents performing each task statement was used to identify tasks and capabilities commonly performed by analysts throughout the United States and Canada.

A criticality value of 2(mean seriousness rating) + mean frequency rating was calculated for each item on the inventory. This formula gives extra weight to the seriousness rating in determining critical items and was appropriate because it emphasized the purpose of certification — to provide competent analysts.

Core Competencies

The ABC Water Laboratory Validation and Examination Committee reviewed the results of the task survey to identify the most important and commonly performed job tasks and capabilities for water laboratory analysts. The essential tasks and capabilities that were identified through this process are called the core competencies.

The following pages list the core competencies for water laboratory analysts. The core competencies are clustered into the following job duties:

- Collect and preserve samples
- Prepare samples for analysis
- Analyze samples and interpret results
- Operate and maintain equipment and instruments
- Handle chemicals and wastes
- Quality assurance/quality control
- Manage laboratory
- Laboratory safety

Collect and Preserve Samples	Class I	Class II	Class III	Class IV
Alkalinity	x	x	x	x
Ammonia	x	x	x	x
Chloride	x	x	x	x
Disinfectant residual	x	x	x	x
Coliform	x	x	x	x
Conductivity	x	x	x	x
Cyanide			x	x
Fluoride	x	x	x	x
Hardness	x	x	x	x
Heterotrophic plate count	x	x	x	x
Jar tests	x	x	x	x
Metals			x	x
Microbiology of algae and water organisms		x	x	x
Multiple tube for MPN	x	x	x	x
Nitrate/Nitrite	x	x	x	x
Organics		x	x	x
pH	x	x	x	x
Phosphorus	x	x	x	x
Polychlorinated biphenyls (PCBs)		x	x	x
Solids	x	x	x	x
Sulfate	x	x	x	x
Temperature	x	x	x	x
Turbidity	x	x	x	x

Required capabilities:

- Ability to determine appropriate sample location
- Be familiar with chain of custody procedures
- Be familiar with holding times, preservatives, and storage conditions
- Be familiar with permit requirements
- Be familiar with personal protective equipment
- Be familiar with safety procedures for sample collection and preservation
- Be familiar with sample identification and labeling procedures
- Be familiar with the sterilization process
- Knowledge of biology and chemistry
- Knowledge of contamination sources
- Knowledge of duplicates and splits
- Knowledge of sample types
- Knowledge of sampler setup
- Knowledge of sampling techniques and equipment

Prepare Samples for Analysis	Class I	Class II	Class III	Class IV
Digestion		x	x	x
Dilution	x	x	x	x
Distillation		x	x	x
Extraction			x	x
Filtration	x	x	x	x
Laboratory pure water	x	x	x	x
Matrix modifiers			x	x
Media preparation	x	x	x	x
Mixing	x	x	x	x
pH adjustment	x	x	x	x
Reagent addition and preparation	x	x	x	x
Sample concentration	x	x	x	x
Temperature adjustment	x	x	x	x

Required capabilities:

- Ability to identify common laboratory apparatus and glassware
- Ability to maintain and operate equipment/instruments
- Ability to perform calculations
- Ability to prepare reagents
- Ability to store and handle chemicals
- Ability to weigh/measure accurately
- Be familiar with dilution techniques
- Be familiar with documentation requirements
- Be familiar with laboratory pure water standards
- Be familiar with Material Safety Data Sheets
- Be familiar with personal protective equipment
- Be familiar with QA/QC practices
- Be familiar with safety procedures
- Knowledge of apparatus preparation
- Knowledge of contamination sources
- Knowledge of holding times
- Knowledge of interferences
- Knowledge of method limitations
- Knowledge of reagent purity
- Knowledge of sample preparation techniques
- Knowledge of laboratory pure water classification (types I, II, III)

Core Competencies (continued)

Analyze Samples and Interpret Results	Class I	Class II	Class III	Class IV
Alkalinity	x	x	x	x
Ammonia		x	x	x
Chloride	x	x	x	x
Disinfectant residual	x	x	x	x
Coliform	x	x	x	x
Conductivity	x	x	x	x
Cyanide			x	x
Fluoride	x	x	x	x
Hardness	x	x	x	x
Heterotrophic plate count	x	x	x	x
Jar tests	x	x	x	x
Metals			x	x
Microbiology of algae and water organisms		x	x	x
Multiple tube for MPN		x	x	x
Nitrate/Nitrite	x	x	x	x
Organics			x	x
pH	x	x	x	x
Phosphorus		x	x	x
Polychlorinated biphenyls (PCBs)				x
Solids	x	x	x	x
Sulfate		x	x	x
Temperature	x	x	x	x
Turbidity	x	x	x	x
Tasks Performed	**Class I**	**Class II**	**Class III**	**Class IV**
Calibrate and check instruments	x	x	x	x
Flow and loading calculations	x	x	x	x
Optimize equipment and instruments	x	x	x	x
Perform titrations	x	x	x	x
Prepare standards	x	x	x	x
Prepare standard curve	x	x	x	x
Reduce data and perform calculations	x	x	x	x
Record results	x	x	x	x
Review data	x	x	x	x
Interpret results	x	x	x	x

Analyze Samples and Interpret Results (continued)

Required capabilities:

- Ability to calibrate instruments
- Ability to determine appropriate sample volume
- Ability to evaluate and interpret data
- Ability to follow written procedures
- Ability to recognize abnormal analytical results and determine appropriate corrective action
- Ability to select proper test method
- Ability to summarize results of analysis
- Ability to use aseptic techniques
- Be familiar with common acid and alkali solutions
- Be familiar with normal characteristics of water
- Be familiar with QA/QC practices
- Be familiar with reporting requirements
- Knowledge of additive volumes
- Knowledge of analytical procedures
- Knowledge of basic math and statistics
- Knowledge of biology and chemistry
- Knowledge of interferences
- Knowledge of method limitations

Core Competencies (continued)

Operate and Maintain Equipment and Instruments	Class I	Class II	Class III	Class IV
Operate equipment:				
Amperometric titrator	x	x	x	x
Apparatus and glassware	x	x	x	x
Atomic absorption spectrophotometer (flame and furnace)			x	x
Autoanalyzer (mercury, cyanide)			x	x
Autoclave	x	x	x	x
Balances	x	x	x	x
Cold vapor atomic absorption spectrophotometer			x	x
Computer	x	x	x	x
Continuous flow analyzer	x	x	x	x
Desiccators	x	x	x	x
Digestion apparatus		x	x	x
Distillation apparatus	x	x	x	x
Gas chromatograph (GC) and GC/MS			x	x
ICP/ and ICP/MS			x	x
Incubator	x	x	x	x
Ion specific electrodes (ammonia)	x	x	x	x
Microscope	x	x	x	x
Oven and muffle furnace	x	x	x	x
pH and conductivity meters	x	x	x	x
Turbidimeter	x	x	x	x
UV/Vis spectrophotometer/color	x	x	x	x
Water purification equipment	x	x	x	x
Maintain equipment and instruments:				
Calibrate equipment/instruments	x	x	x	x
Clean equipment/instruments	x	x	x	x
Retain maintenance contracts		x	x	x
Store equipment/instruments	x	x	x	x
Troubleshoot equipment/instruments	x	x	x	x
Retain maintenance logs	x	x	x	x

Required capabilities:

- Ability to determine appropriate corrective action
- Ability to follow written procedures
- Ability to identify common laboratory apparatus and glassware
- Ability to interpret manuals
- Be familiar with EPA approved procedures
- Be familiar with labware cleaning procedures
- Be familiar with proper installation procedures
- Be familiar with recordkeeping requirements
- Knowledge of basic math
- Knowledge of biology and chemistry
- Knowledge of computers
- Knowledge of electronic equipment
- Knowledge of instrumental techniques

Handle Chemicals and Wastes	Class I	Class II	Class III	Class IV
Dispose of laboratory wastes:				
Biohazard	x	x	x	x
Expired and excess reagents	x	x	x	x
Glassware	x	x	x	x
Waste minimization and pollution prevention	x	x	x	x
Store and handle containers:				
Label containers	x	x	x	x
Maintain inventory	x	x	x	x
Maintain security	x	x	x	x
Maintain current Material Safety Data Sheet files	x	x	x	x
Segregate chemicals	x	x	x	x

Required capabilities:

- Ability to store and handle chemicals safely
- Be familiar with labeling requirements
- Be familiar with Material Safety Data Sheets
- Be familiar with personal protective equipment
- Be familiar with regulations
- Be familiar with waste storage requirements
- Knowledge of chemical compatibility, storage limitations and expiration dates
- Knowledge of chemical hygiene plan
- Knowledge of chemical spill cleanup procedures and hazard management plan
- Knowledge of holding times
- Knowledge of pollution prevention methods
- Knowledge of safety procedures
- Knowledge of pathogens

Quality Assurance/Quality Control	Class I	Class II	Class III	Class IV
Conduct internal audits				x
Develop, maintain and interpret control charts	x	x	x	x
Establish method detection/reporting limits		x	x	x
Establish quality assurance plans		x	x	x
Maintain method detection/reporting limits	x	x	x	x
Maintain training records				x
Perform corrective actions	x	x	x	x
Conduct proficiency tests	x	x	x	x
Validate data	x	x	x	x

Required capabilities:

- Ability to determine appropriate corrective action
- Be familiar with approved analytical methods
- Be familiar with permit and recordkeeping requirements
- Be familiar with regulations
- Knowledge of auditing procedures
- Knowledge of basic statistics
- Knowledge of chemistry
- Knowledge of computer spreadsheets and databases

Core Competencies (continued)

Manage Laboratory	Class I	Class II	Class III	Class IV
Administer security, safety and compliance program	x	x	x	x
Develop and maintain standard operating procedures		x	x	x
Ensure staff is trained		x	x	x
Maintain analyst certification	x	x	x	x
Maintain laboratory certification				x
Maintain records	x	x	x	x
Maintain regulatory compliance/ethics	x	x	x	x
Order supplies		x	x	x
Organize and plan work activities	x	x	x	x
Promote public relations				x
Respond to complaints				x
Supervise operation of laboratory				x
Write reports (federal, state, internal)	x	x	x	x
Establish Recordkeeping System:				
Analytical				x
Documentation				x
Maintenance				x
Personnel				x
Record Information:				
Analytical	x	x	x	x
Documentation	x	x	x	x
Financial				x
Maintenance	x	x	x	x
Personnel				x

Required capabilities:

- Ability to accurately transcribe data
- Ability to determine what information needs to be recorded
- Ability to evaluate laboratory performance
- Ability to evaluate and interpret data
- Ability to generate plans
- Ability to summarize results of analysis
- Be familiar with documentation requirements
- Be familiar with permit requirements
- Be familiar with regulations
- Be familiar with reporting requirements
- Knowledge of approved analytical methods
- Knowledge of basic math
- Knowledge of computer spreadsheets and databases
- Knowledge of customer service principles
- Knowledge of principles of communication
- Knowledge of principles of management
- Knowledge of principles of project management
- Knowledge of principles of public relations
- Knowledge of recordkeeping policies
- Knowledge of water treatment processes

Laboratory Safety	Class I	Class II	Class III	Class IV
Establish safety programs for:				
Burns		x	x	x
Chemicals	x	x	x	x
Compressed gases				x
Confined space				x
Electrical shock				x
Fire				x
General safety and health	x	x	x	x
Housekeeping	x	x	x	x
Infectious materials		x	x	x
Personal hygiene	x	x	x	x
Personal protective equipment	x	x	x	x
Showers and eyewash stations	x	x	x	x
Spill response and cleanup		x	x	x
Toxic fumes				x
Perform safety procedures for:				
Burns	x	x	x	x
Chemicals	x	x	x	x
Compressed gases	x	x	x	x
Confined space	x	x	x	x
Electrical shock	x	x	x	x
Fire	x	x	x	x
General safety and health	x	x	x	x
Housekeeping	x	x	x	x
Infectious materials	x	x	x	x
Personal hygiene	x	x	x	x
Personal protective equipment	x	x	x	x
Showers and eyewash stations	x	x	x	x
Spill response and cleanup	x	x	x	x
Toxic fumes	x	x	x	x

Required capabilities:

- Ability to communicate verbally and in writing
- Ability to operate equipment
- Ability to recognize unsafe work conditions
- Ability to select safety equipment
- Be familiar with Material Safety Data Sheets
- Be familiar with personal protective equipment
- Be familiar with regulations
- Knowledge of chemical hygiene plan
- Knowledge of compressed gas cylinder handling hazards
- Knowledge of confined space characteristics
- Knowledge of fume hood operation
- Knowledge of safety procedures and emergency plan

Water Laboratory Analyst Certification Exams

The ABC water laboratory analyst certification exams evaluate an analyst's knowledge of tasks related to the operation of water laboratories. Each exam is based on the core competencies listed in this Need-to-Know Criteria. To successfully take an ABC exam, an analyst must demonstrate knowledge of these core competencies.

Four levels of certification are offered by ABC, with class I being the lowest level and class IV the highest level. The specifications for the exams are based on a weighting of the job analysis results so that they reflect the criticality of tasks performed on the job. The specifications list the percentage of questions on the exam that fall under each job duty. For example, 17% of the class I exam consists of questions relating to the job duty "collect and preserve samples" and its associated tasks and capabilities. For a list of tasks and capabilities associated with each job duty, please refer to the list of core competencies on the previous pages.

ABC Water Laboratory Exam Specifications

	Exam Level			
	I	II	III	IV
Collect and Preserve Samples	17%	12%	5%	5%
Prepare Samples for Analysis	12%	19%	14%	5%
Analyze Samples and Interpret Results	24%	19%	21%	7%
Operate and Maintain Equipment/Instruments	14%	11%	14%	7%
Handle Chemicals and Wastes	5%	8%	8%	5%
Quality Assurance/Quality Control	9%	9%	15%	18%
Manage Laboratory	5%	8%	9%	34%
Laboratory Safety	9%	9%	9%	14%
General Science	5%	5%	5%	5%

Suggested Exam References

The following are approved as reference sources for the ABC examinations. Analysts should use the latest edition of these reference sources to prepare for the exam.

- American Public Health Association (APHA), American Water Works Association, and Water Environment Federation. *Standard Methods for the Examination of Water and Wastewater* (latest EPA-approved edition). Washington, DC: APHA. (www.apha.org)
- California State University, Sacramento (CSUS) Foundation, Office of Water Programs. 2001. *Water Treatment Plant Operation*, Vol. I and II. Sacramento, CA: CSUS Foundation. (www.owp.csus.edu)
- California State University, Sacramento (CSUS) Foundation, Office of Water Programs. 2001. *Utility Management*. Sacramento, CA: CSUS Foundation. (www.owp.csus.edu)
- California State University, Sacramento (CSUS) Foundation, Office of Water Programs. 2005. *Manage for Success*. Sacramento, CA: CSUS Foundation. (www.owp.csus.edu)
- *Code of Federal Regulations*. "Occupational Safety and Health Standards." Title 29 (Labor), Chapter XVII, Part 1910. (www.gpo.gov)

(continued)

Suggested Exam References *(continued)*

- *Code of Federal Regulations*. Title 40 (Protection of Environment), Chapter I, Parts 136, 261, 433, 501, and 503. (www.gpo.gov)
- Csuros, Maria, and Csaba Csuros. 2002. *Environmental Sampling and Analysis for Metals*. Boca Raton, FL: CRC Press. (www.crcpress.com)
- Csuros, Maria. 1994. *Environmental Sampling and Analysis for Technicians*. Boca Raton, FL: CRC Press. (www.crcpress.com)
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- Smith, Roy-Keith. 1995. *Water and Wastewater Laboratory Techniques*. Alexandria, VA: Water Environment Federation. (www.wef.org)
- U.S. Environmental Protection Agency (US EPA). 1979. *Handbook for Analytical Quality Control in Water and Wastewater Laboratories*. EPA Number 600479019. Cincinnati, OH: US EPA. (www.epa.gov/nepis/)
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