ABC Need-to-Know Criteria for Water Laboratory Analysts

ABC

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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

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.

ABC Core Competencies for Water Laboratory Analysts

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)

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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)
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