THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

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ETV Joint Verification Statement

TECHNOLOGY TYPE:	**Rapid Toxicity Testing System**	
APPLICATION:	**Detecting Toxicity in Drinking Water**	
TECHNOLOGY NAME:	**Chem-IQ Tox™**	
COMPANY:	**Aqua Survey, Inc.**	
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The U.S. Environmental Protection Agency (EPA) has established the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies. Information and ETV documents are available at www.epa.gov/etv.

ETV works in partnership with recognized standards and testing organizations, with stakeholder groups (consisting of buyers, vendor organizations, and permitters), and with individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance (QA) protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

The Advanced Monitoring Systems (AMS) Center, one of six technology areas under ETV, is operated by Battelle in cooperation with EPA's National Exposure Research Laboratory. The AMS Center evaluated the performance of the Aqua Survey, Inc. Chem-IQ Tox™ Test Kit. This verification statement provides a summary of the test results.

VERIFICATION TEST DESCRIPTION

Rapid toxicity technologies use various biological organisms and chemical reactions to indicate the presence of toxic contaminants. The toxic contaminants are indicated by a change or appearance of color or a change in intensity. As part of this verification test, the Chem-IQ Tox™ Test Kit was subjected to various concentrations of contaminants such as industrial chemicals, pesticides, rodenticides, pharmaceuticals, nerve agents, and biological toxins. Each contaminant was added to separate drinking water samples and analyzed. In addition to determining whether the Chem-IQ Tox™ Test Kit could detect the toxicity caused by each contaminant, its response to interfering compounds, such as water treatment chemicals and by-products in clean drinking water, was evaluated.

The Chem-IQ Tox™ Test Kit was evaluated by

- Endpoints and precision—percent inhibition for all concentration levels of contaminants and potential interfering compounds and precision of replicate analyses

- Toxicity threshold for each contaminant—contaminant level at which higher concentrations generate inhibition significantly greater than the negative control and lower concentrations do not. Note that Aqua Survey, Inc. recommends that a 20% inhibition is required for a conclusive indication of toxicity. During this test, a thorough evaluation of the toxicity threshold was performed. Therefore, the toxicity threshold was determined with respect to the negative control rather than the 20% inhibition threshold

- False positive responses—chlorination and chloramination by-product inhibition with respect to unspiked American Society for Testing and Materials Type II deionized water samples

- False negative responses—contaminants that were reported as producing inhibition less than 20% when present at lethal concentrations (the concentration at which 250 milliliters of water would probably cause the death of a 154-pound person) or negative background inhibition that caused falsely low inhibition

- Other performance factors (sample throughput, ease of use, reliability).

The Chem-IQ Tox™ Test Kit was verified by analyzing a dechlorinated drinking water sample from Columbus, Ohio (DDW), fortified with contaminants (at concentrations ranging from lethal levels to concentrations up to 1,000 times less than the lethal dose) and interferences (metals possibly present as a result of the water treatment processes). Dechlorinated water was used because free chlorine can interfere with the performance of the test and can degrade the contaminants during storage. Inhibition (endpoints) from four replicates of each contaminant at each concentration level were evaluated to assess the ability of the Chem-IQ Tox™ Test Kit to detect toxicity, as well as to measure the precision of the Chem-IQ Tox™ Test Kit results. The response of the Chem-IQ Tox™ Test Kit to possible interferents was evaluated by analyzing them at one-half of the concentration limit recommended by the EPA's National Secondary Drinking Water Regulations guidance. For analysis of by-products of the chlorination process, the unspiked DDW was analyzed because Columbus, Ohio, uses chlorination as its disinfectant procedure. For the analysis of by-products of the chloramination process, a separate drinking water sample was obtained from the Metropolitan Water District of Southern California (LaVerne, California), which uses chloramination as its disinfection process. The samples were analyzed after residual chlorine was removed using sodium thiosulfate. Sample throughput was measured based on the number of samples analyzed per hour. Ease of use and reliability were determined based on documented observations of the operators.

Quality control samples included method blank samples, which consisted of American Society for Testing and Materials Type II deionized water; positive control samples (fortified with copper chloride); and negative control samples, which consisted of the unspiked DDW.

QA oversight of verification testing was provided by Battelle and EPA. Battelle QA staff conducted a technical systems audit, a performance evaluation audit, and a data quality audit of 10% of the test data.

This verification statement, the full report on which it is based, and the test/QA plan for this verification test are all available at www.epa.gov/etv/centers/center1.html.

TECHNOLOGY DESCRIPTION

The following description of the Chem-IQ Tox™ Test Kit is based on information provided by the vendor. This technology description was not verified in this test.

The Chem-IQ Tox™ Test Kit detects toxicants in drinking water using a chemical reaction that generates fluorescence. The test can be conducted by a technician with basic laboratory skills. Sample analysis is performed by adding two reagents to test and control water samples and measuring each sample's fluorescence with a calibrated fluorometer. Percent inhibition values are calculated by comparing the light production of the control with that of the test samples. If the average percent inhibition value of the replicate test samples is greater than 20%, the test water sample is considered significantly impacted by a toxicant and considered a positive response.

The Chem-IQ Tox™ Test Kit, which costs $250, contains 30 vials each of two reagents, 90 IQ Exposure Chambers, disposal reagent pipettes, Chem-IQ Tox™ Test Kit score cards, and a Sharpie pen. Materials and laboratory equipment required for the test include an Aquafluor™ hand-held fluorometer (Turner Design) or equivalent and a supply of non-fluorescing 4 milliliter cuvettes (10 millimeter by 10 millimeter); an automatic pipetter or equivalent with appropriate disposable tips for dispensing 10-milliliter, 250-microliter, and 50-microliter volumes; a PC3 liquid sonicator (L&R) or equivalent; a magnetic stir plate and stir bar (1/8 inch diameter); a distilled or deionized water supply; and a digital timer that displays seconds.

VERIFICATION RESULTS

Parameter	Compound	Lethal Dose (LD) Conc. (mg/L)	Average Inhibition at Concentrations Relative to the LD Concentration (%)				Range of Standard Deviations (%)	Toxicity Thresh. (mg/L)
			LD	LD/10	LD/100	LD/1,000		
Contaminants in DDW	Aldicarb	260	-16	13	-33	7	9-32	ND
	Botulinum toxin complex B	0.3	-62	1	4	5	3-8	ND
	Colchicine	240	104	63	17	42	2-15	24
	Cyanide	250	63	47	-21	-18	2-24	25
	Dicrotophos	1,400	-55	-30	-38	-13	8-41	ND
	Nicotine	2,800	50	84	71	-3	1-12	28
	Ricin	15	-44	-13	10	-3	4-12	ND
	Soman	1.4	16	-8	19	7	1-6	ND
	Thallium sulfate	2,800	66	16	-5	-25	3-13	2,800
	VX	2	-44	-36	-14	-13	8-26	ND
	Interference	**Conc. (mg/L)**	**Average Inhibition (%)**		**Standard Deviation (%)**			
	Aluminum	0.5	4		9			
	Copper	0.6	46		3			
	Iron	0.15	-26		20			
	Manganese	0.25	11		9			
	Zinc	2.5	34		2			
False positive response	Because DI water did not generate any measurable background light, the disinfection by-product samples could not be compared with the inhibition due to DI water. Therefore only the absolute light units produced by the chlorinated and chloraminated samples could be measured. Both of these samples left adequate light for subsequent inhibition due to contamination and are thus not considered to have generated false positive results.							
False negative response	False negative responses (inhibition less than 20%) were generated for aldicarb, botulinum toxin, complex B, dicrotophos, ricin, soman, and VX when they were analyzed at the lethal dose concentration.							
Ease of use	The Chem-IQ Tox™ Test Kit instructions were clearly written; but a condensed summary with only the necessary steps may be helpful. The contents of the Chem-IQ Tox™ Test Kit were well identified. The test was not difficult to perform, but analyzing several samples simultaneously required practice. No formal scientific education would be required to use the Test Kit.							
Field portability	The Chem-IQ Tox™ Test Kit was transported from a laboratory to a storage room to simulate a non-laboratory location. All materials were easily transported by one person in a small cardboard box. The Test Kit was set up in less than 10 minutes, except that Reagent Two took approximately 20 minutes to thaw. A source of electricity was required for the sonicator, while the fluorometer ran on batteries. A cooler to transport and store reagents, pipettes and tips, the sonicator and a power source, the fluorometer, and a waste container were needed for field use. Results were obtained within 10 minutes of starting the test.							
Throughput	Approximately 30 analyses were completed in one hour. The 30 analyses included method blanks, positive controls, and test samples. Approximately 130 samples could be processed per pair of Reagent One and Reagent Two vials.							

ND = Significant inhibition was not detected.

Original signed by Gregory A. Mack 6/22/06	Original signed by Andrew P. Avel 8/7/06
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