THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**ARSENIC TEST KIT**	
APPLICATION:	**ANALYSIS OF ARSENIC IN WATER**	
TECHNOLOGY NAME:	**Quick™ Low Range**	
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The U.S. Environmental Protection Agency (EPA) supports 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.

ETV works in partnership with recognized standards and testing organizations; with stakeholder groups that consist of buyers, vendor organizations, and permitters; and with the full participation of 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 seven technology areas under ETV, is operated by Battelle in cooperation with EPA's National Exposure Research Laboratory. The AMS Center has recently evaluated the performance of portable analyzers for arsenic in water. This verification statement provides a summary of the test results for the Industrial Test Systems, Inc. Quick™ Low Range test kit for measuring arsenic in water.

VERIFICATION TEST DESCRIPTION

The Quick™ Low Range test kit is a portable, rapid device designed for on-site analysis of arsenic in water. The Quick™ Low Range test kit was verified in terms of its performance on the following parameters: accuracy, precision, linearity, method detection limit (MDL), matrix interference effects, operator bias, inter-unit reproducibility, and rate of false positives/false negatives. All preparation and analyses were performed according to the manufacturer's recommended procedures. Results from the Quick™ Low Range test kit and Quick™ Arsenic Scan detection device were compared to those from the reference method to assess accuracy, linearity, and detection limit. Multiple aliquots of performance test samples and environmental samples were analyzed to assess precision. Matrix interference effects were assessed by challenging the test kit with performance test samples of known arsenic concentrations containing both low-level and high-level interferences. Identical sets of samples were analyzed independently by two separate operators (a technical and a non-technical Battelle staff member) to evaluate operator bias. All samples were analyzed using two Quick™ Arsenic Scan units to evaluate inter-unit reproducibility. False positives and negatives were evaluated relative to the 10-ppb maximum contaminant level for arsenic in drinking water. In addition to the analytical results, the time required for sample analysis and operator observations concerning the use of the test kit (e.g., frequency of calibration, ease of use, maintenance) were recorded.

Three types of samples were used in the verification test: quality control (QC) samples, performance test (PT) samples, and environmental water samples. The QC and PT samples were prepared from National Institute of Standards and Technology traceable purchased standards. The environmental water samples were collected from various drinking water and surface water sources. All samples were analyzed using the Quick™ Low Range test kits and by a laboratory reference method.

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

TECHNOLOGY DESCRIPTION

The following description was provided by the vendor and does not represent verified information.

The optimal detection range for the Quick™ Low Range test kit is below 20 ppb arsenic. Dilution instructions are provided for samples with arsenic levels above 30 ppb. The recommended temperature range for sample analysis is 24°C to 30°C. A modified testing protocol is available for sample temperatures below this range. To perform arsenic analyses with the Quick™ Low Range test kit, the water sample to be tested is mixed in the supplied reaction vessel with reagent #1 (tartaric acid with rate enhancers) to acidify the water sample. Reagent #2, an oxidizer (potassium peroxymonosulfate), is added to remove hydrogen sulfide interference. The test tolerates up to 2 ppm hydrogen sulfide without interference. Zinc powder, reagent #3, is added to reduce inorganic arsenic compounds (As^{+3} and As^{+5}) to arsine gas. As arsine gas is generated and comes in contact with the test strip, the mercuric bromide indicator on the test strip changes color from white to shades of yellow or brown. Material Safety Data Sheets (MSDS) for all reagents and test strips are provided with each test kit. The MSDSs include information on how to safely handle the reagents and test strips, including instructions for exposure controls and personal protection.

Once the reaction is completed, the test strip is removed and visually compared to a color chart to obtain a semi-quantitative measure of the arsenic concentration in the tested sample. The color chart consists of a series of color blocks that correspond to concentrations ranging from 3 ppb to >80 ppb. The test strip may also be read with the Quick™ Arsenic Scan hand-held instrument, which operates on the same principle as a colorimeter and provides a quantitative result. The Quick™ Arsenic Scan is calibrated weekly using a calibration card provided by the manufacturer. The Quick™ Arsenic Scan is not provided with the test kit as a standard feature. The standard test kit with the color chart was the subject of this verification test; however, results for the Quick™ Arsenic Scan are also provided. The kits are available in two sizes: two tests and 50 tests. The typical shelf life of the kits is 24 months.

VERIFICATION OF PERFORMANCE

Accuracy: The quantitative assessment of accuracy indicated that the relative bias for the color chart ranged from -38% to 239% for the technical operator and -81% to 579% for the non-technical operator. The highest values were associated with sample concentrations near the detection limit. The relative bias for the Quick™ Arsenic Scan ranged from -93% to 99% for the technical operator and -86% to 66% for the non-technical operator. The overall agreement for the color chart results based on an assessment of whether the result was assigned to the correct color block indicated that the total percent agreement was 81% for the technical operator and 74% for the non-technical operator.

Precision: Precision was assessed by analyzing four replicates of each sample. For the technical operator, precision expressed as a relative standard deviation (RSD) ranged from 0% to 10% for the color chart and 5% to 23% for the Quick™ Arsenic Scan. For the non-technical operator, RSDs ranged from 0% to 23% for the color chart and 0% to 42% for the Quick™ Arsenic Scan.

Linearity: The linearity of response was evaluated by plotting the test kit results against the reference analysis results for the PT samples. The equations for the linear regressions that were performed to evaluate linearity are as follows, where x is the reference method concentration and y is the test kit concentration:

Color chart, technical operator	$y = 0.83x + 2.61$, R = 0.9992
Color chart, non-technical operator	$y = 0.90x + 2.78$, R = 0.9805
Quick™ Arsenic Scan #1, technical operator	$y = 0.85x + 0.83$, R = 0.9972
Quick™ Arsenic Scan #2, technical operator	$y = 0.87x + 0.41$, R = 0.9939
Quick™ Arsenic Scan #1, non-technical operator	$y = 0.68x + 0.99$, R = 0.9660

Method Detection Limit: The MDL was assessed by analyzing seven replicates of a sample spiked at a level approximately five times the manufacturer's estimated detection limit for the color chart (i.e., 3 ppb X 5 = 15 ppb). The MDLs calculated using the precision data from these replicates ranged from 3.1 ppb to 6.7 ppb for the color charts and 4.0 ppb to 7.2 ppb for the Quick™ Arsenic Scan.

Matrix Interference Effects: Results for samples containing low and high levels of interfering compounds (sodium chloride, sulfide and iron) indicated that low levels of interferents did not appear to affect the detection of arsenic; however, high levels of interferences appear to have affected the arsenic levels measured by the Quick™ Low Range test kit. Positive biases associated with these samples were higher than those measured for samples containing arsenic only.

Operator Bias: The color chart measurements made by the non-technical operator tended to be higher than for the technical operator, and the Quick™ Arsenic Scan measurements tended to be higher for the technical operator. Paired t-tests of the two sets of data indicated that the color chart results were not significantly different at a 5% significance level; however, the Quick™ Arsenic Scan results were significantly different for the two operators.

Inter-Unit Reproducibility: Inter-unit reproducibility was evaluated by comparing the data for the two Quick™ Arsenic Scan units used by the technical operator. A linear regression of the two sets of data indicated that the results closely corresponded. A paired t-test of the two sets of data indicated that the results were not significantly different at a 5% significance level.

Rate of False Positives/False Negatives: The rates of false positives and false negatives for the Quick™ Low Range test kit were assessed relative to the reference method using 10 ppb arsenic as the decision level. The rates of false positives for the technical and non-technical operators using the color charts were 3% and 12.5%, respectively. The rates of false positives for the Quick™ Arsenic Scan units were 3% and 0% for the technical operator (Units #1 and #2, respectively) and 3% for the non-technical operator (Unit #1 only). The false negative rates for the technical and non-technical operators using the color charts were 0% and 14%, respectively. The rates of false negatives for the Quick™ Arsenic Scan units were 19% and 14% for the technical operator (Units #1 and #2, respectively) and 9.5% for the non-technical operator (Unit #1 only).

Other Factors: The Quick™ Low Range test kits were easy to use and readily transportable to the field. The time to analyze one sample was approximately 15 minutes at a temperature range of 24°C to 30°C (longer reaction times are required for samples below this temperature range). Two samples were run concurrently without difficulty. The sample bottles were of moderate size and were relatively easy to handle, although the narrow neck sometimes caused spillage during the addition of reagents. The cost for a 50-sample test kit with the color chart is listed as $179.99. Replacement reagents and supplies are not available; kits are provided as a complete set because reagents, test strips, and color charts are made to perform optimally with each other, according to the vendor. The Quick™ Arsenic Scan is available as an option for an additional cost of $1,599.99.

signed by Gabor J. Kovacs	8/7/03	signed by Gary J. Foley	9/30/03
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