THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**ARSENIC TEST KIT**
APPLICATION:	**ANALYSIS OF ARSENIC IN WATER**
TECHNOLOGY NAME:	**Quick™ II**
COMPANY:	**Industrial Test Systems, Inc.**
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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™ II test kit for measuring arsenic in water.

VERIFICATION TEST DESCRIPTION

The Quick™ II test kit is a portable, rapid device designed for on-site analysis of arsenic in water. The Quick™ II 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™ II test kit 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 and two Compu-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™ II 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™ II test kit is below 10 ppb arsenic. Dilution instructions are provided for samples with arsenic levels above 15 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™ II 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 2 ppb to >150 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. Quantitative results may also be obtained from the test strip with a portable Compu-Scan scanner and laptop system. The scanned test strip image is converted to an arsenic concentration using the Home Port Computer System Arsenic Program Revision 5b software. The scanner is calibrated by the manufacturer. The Quick™ Arsenic Scan and Compu-Scan are not provided with the Quick™ II 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 and Compu-Scan were also provided. The Quick™ II test kits are available in sets of 50 tests. The typical shelf life of the kits is 24 months.

VERIFICATION OF PERFORMANCE

Accuracy: The bias for the Quick™ II color chart ranged from -61% to 10% for the technical operator and from -77% to 96% for the non-technical operator. The bias for the Quick™ Arsenic Scan ranged from -78% to -4% for the technical operator and from -85% to -22% for the non-technical operator. The bias for the Compu-Scan ranged from -71% to 96% for the technical operator and from -82% to 108% 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 68% for the technical operator and 72% for the non-technical operator.

Precision: For the technical operator, precision expressed as a relative standard deviation (RSD) ranged from 16% to 24% for the color chart, 11% to 44% for the Quick™ Arsenic Scan and 10% to 58% for the Compu-Scan. For the non-technical operator, RSDs ranged from 0% to 38% for the color chart, 13% to 38% for the Quick™ Arsenic Scan and 16% to 108% for the Compu-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	$y = 0.88x - 1.82$, R = 0.9779
Color chart, non-technical operator	$y = 0.52x + 3.37$, R =0.9822
Quick™ Arsenic Scan #1, technical operator	$y = 0.75x - 2.42$, R =0.9340
Quick™ Arsenic Scan #2, technical operator	$y = 0.66x - 0.30$, R =0.9565
Quick™ Arsenic Scan #1, non-technical operator	$y = 0.59x + 0.095$, R =0.9828
Compu-Scan #1, technical operator	$y = 0.85x - 2.67$, R =0.9301
Compu-Scan #2, technical operator	$y = 1.39x - 5.12$, R =0.9117
Compu-Scan #1, non-technical operator	$y = 0.73x - 0.55$, R =0.9787

Method Detection Limit: The MDLs calculated using precision data from seven replicates of a low-level spiked sample ranged from 3.6 ppb to 7 ppb for the color chart, 4.5 ppb to 6.1 ppb for the Quick™ Arsenic Scan, and 3.7 ppb to 18.2 ppb for the Compu-Scan.

Matrix Interference Effects: Low and high levels of interferents did not appear to affect the detection of arsenic. Biases for these samples were similar to those calculated for PT samples containing arsenic only.

Operator Bias: Measurements for the color chart, Quick™ Arsenic Scan, and Compu-Scan done by the technical operator tended to be higher than for the non-technical operator. Paired t-tests indicated that the results were not significantly different at a 5% significance level for the Quick™ Arsenic Scan and Compu-Scan results. Color chart results for the technical and non-technical operators were significantly different.

Inter-Unit Reproducibility: The results for the two Quick™ Arsenic Scan units almost exactly corresponded, indicating that the performance of the two units was very similar. The data for the Compu-Scan units showed more scatter, and Unit #2 tended to return higher results than Unit #1. Paired t-tests of the two sets of data indicated that the Quick™ Arsenic Scan results were not significantly different at a 5% significance level whereas the results for the two Compu-Scan units were significantly different.

Rate of False Positives/False Negatives: The false positive rates for the technical and non-technical operators using the color charts and Quick™ Arsenic Scan units were all 0%. The false positive rates for the Compu-Scan units were 3% and 9% for the technical operator (Units #1 and #2) and 0% for the non-technical operator (Unit #1). The false negative rates for the non-technical and technical operators using the color charts were 19% and 24%, respectively. The false negative rates for the Quick™ Arsenic Scan units were 33% and 19% for the technical operator (Units #1 and #2, respectively) and 29% for the non-technical operator (Unit #1). The false negative rates for the Compu-Scan units were 38% and 10% for the technical operator (Units #1 and #2, respectively) and was 14% for the non-technical operator (Unit #1).

Other Factors: The Quick™ II test kits were easy to use and readily transportable to the field. The time to analyze one sample is approximately 15 minutes at a temperature range of 24°C to 30°C; longer reaction times are required for samples below this range. Two samples can be run concurrently without difficulty. The sample bottles were of moderate size and were relatively easy to handle. The test kit components were reliable. Dilution of samples with arsenic concentrations exceeding the optimal detection range may be a source of error and reduce the accuracy and precision of the associated results because of the difficulty in performing accurate dilution in a field setting. The cost for a 50-sample test kit with a color chart is listed as $219.99. 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 and Compu-Scan are available as options for an additional cost of $1,599.99 each.

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