THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**MULTI-PARAMETER WATER SENSOR**
APPLICATION:	**MONITORING DRINKING WATER QUALITY**
TECHNOLOGY NAME:	**WaterPOINT 870**
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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.

VERIFICATION TEST DESCRIPTION

The performance of the Sensicore WaterPOINT 870 (WP870) was assessed in terms of its accuracy, precision, inter-unit reproducibility, field portability, and ease of use. The verification test was coordinated by Battelle and conducted between April and July 2007 at the Columbus, Ohio Division of Power and Water (CDW) laboratories. The verification test consisted of three stages, each designed to evaluate particular performance characteristics.

Stage 1 consisted of two parts. The first part focused on testing the accuracy and precision of the sensors on water samples prepared in deionized (DI) water with respect to Standard Methods for the Examination of Water and Wastewater laboratory reference methods. The water quality parameters tested included: pH, oxidation-reduction potential (ORP), conductivity, free chlorine, monochloramine, free ammonia, calcium hardness, and total alkalinity. Testing was done by preparing test solutions in DI water with water quality measurements that spanned the working range of the sensor. Individual solutions were prepared that simultaneously represented groupings of the water quality parameters. The second part of Stage 1 focused on testing the accuracy and precision of the sensors over the lifetime of the sensors (30 days or 50 water samples) by testing one concentration level, in triplicate twice, once near the start of the sensor's vendor-specified lifetime and once near the end. Between those analysis times, six finished drinking water samples were analyzed to challenge the sensor with more realistic samples between tests with samples prepared in DI water.

The second stage of this verification test focused on the performance of the WP870 when analyzing six samples of finished drinking water (DW), two drinking water samples within the treatment process (IPW), and two samples of untreated surface water (SW). The IPW and SW samples were analyzed by the WP870 at a booster station within the CDW distribution system and then returned to the laboratory for reference analysis. In addition to the field measurements, all 10 samples were analyzed in the laboratory using the WP870. Stage 1 and 2 samples included triplicate analysis on each of two sensors as well as analysis by reference methods in order to study the accuracy and precision of two different sensors installed on separate WP870 handheld units.

The third stage of this verification test evaluated the ease of using the WP870 during a field water quality study with two collaborators. The ETV program collaborated with 1) personnel from EPA National Exposure Research Laboratory (NERL) who conducted a short-term field analysis campaign in southern Ohio during September 2006 and 2) personnel from the Texas Commission on Environmental Quality (TCEQ) who conducted a similar sampling campaign in western Texas in May 2007. These studies were independent from the ETV test, but EPA NERL and TCEQ agreed to take the WP870 with them and perform single analyses at some of the measurement locations included in their studies. No grab samples were transported for reference analysis during this stage of the testing. Therefore, the focus of this part of the test was the evaluation of the practical aspects of using the WP870 under non-laboratory, field analysis conditions.

Inter-unit reproducibility was assessed by comparing the results of two sensors operating simultaneously. Ease of use was documented by Battelle, CDW, EPA, and TCEQ technicians who operated and maintained the units. 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 WP870 unit was provided by the vendor and does not represent verified information.

The WaterPOINT 870 is a lab-on-chip micro sensor array technology that incorporates chemical selective sensors and physical measuring devices on a single silicon chip. This panel of tests is used to chemically profile drinking water (and/or other liquids) in five minutes. This handheld system was designed for both municipal and industrial applications. It employs Sensicore's platform sensor chip with five membrane based ion selective electrodes capable of detecting light metal ions and dissolved gases, two micro amperometric arrays for detecting free chlorine and monochloramine species, and electronic sensors for measuring oxidation reduction potential (ORP), conductivity, and temperature. All of these sensors are incorporated on a single silicon substrate that is 4 millimeters (mm) × 5 mm in size and conveniently packaged in a semi-disposable unit that also contains its own reference electrode. In all, with the direct measurements and calculated values that can be obtained from the direct measurements, the system reports 16 different results as follows: pH, ORP, conductivity, total dissolved solids, free chlorine, monochloramine, free and total ammonia, chlorine-ammonia ratio, biocide-food ratio, carbon dioxide, total alkalinity, calcium, calcium hardness, total hardness, and

Langelier Saturation Index. Only the direct measurements including pH, ORP, conductivity, free chlorine, monochloramine, free ammonia, calcium hardness, and total alkalinity results were verified during this test. The WP870 handheld system includes several features.

- Incorporates a single point calibration/QC check into every measurement;
- Calibrates all sensors via weekly two-point calibration;
- Transfer of results and sensor diagnostic and calibration information to computer via USB connection;
- Includes sample chain of custody information including time and date stamp, test location (including an optional GPS recording if desired) and a barcode recorder for identifying samples;
- Software is menu driven and requires little training;
- Powered by rechargeable battery;
- Is compatible with WaterNOW software which is an online and secure data service utilizing 128-bit data encryption that helps the users understand the data they have collected through unique visualization and comparison tools. It provides a means for the users to combine data from a variety of locations. Datasets from the WP870 analyzer can be uploaded through the internet or through email attachment. Subscriptions for the WaterNOW service start at $400 per month;
- Has dimensions of approximately 16 centimeters (cm) × 22 cm and weighs 1.75 pounds;
- Completes full analysis within five minutes;
- One time cost of $2,495 for the handheld unit, and $295 for every additional sensor chip that is good for the analysis of 50 samples or for a duration of 30 days following the initial calibration, whichever comes first. New sensors include all necessary calibration solutions and sample buffers and conditioners required for the sample analyses. Note that each sample analysis provides results for all the above listed water quality parameters.

While not evaluated during this test, the WP870 has an Optical Module that includes the following capabilities:

- Turbidity measurements which meet US EPA Method 180.1
- 375 nm wavelength intrinsic color measurements following Standard Method 2120B
- Colorimetric measurements utilizing a red/green/blue light emitting diode and corresponding photodetectors to measure a variety of ampouled chemistries, including Total and Free Chlorine by Standard Method 4500 Cl-G.
- Total hardness ion selective electrode for the determination of hardness due to free calcium and magnesium.
- One time cost of $2,995 for the optic-enabled handheld unit, with sensor kits for free and monochloramine which are good for 90 analyses or up to 60 days ($295-$495), and ion selective electrode sensor kits which are good for 90 tests and up to 60 days ($225-$410).

VERIFICATION RESULTS

The below table summarizes the results from the ETV testing of the WP870. The range of accuracy results are given in percent difference (%D) along with summaries of other verified performance parameters which includes precision which was evaluated through a calculation of percent relative standard deviation (%RSD).

Water Quality (WQ) Parameter	Stage 1 WQ Levels (test samples prepared in DI water)	Stage 1 Accuracy - %D from Ref.	Stage 2 Accuracy - %D from Ref. (DW, IPW, and SW)
Alkalinity	22, 130, and 240 mg/L $CaCO_3$	-20 to 4.0	-26.4 to 8.0
Ammonia	0.1, 0.8, 1.5 mg/L	-23.8 to 47.1	Ref. result below detection limit
Conductivity	100, 1100, 1700 µS/cm	0.3 to 5.7	-0.9 to 5.5
Free Chlorine	0.2, 1.2, 2.2 mg/L	-41.2 to 26.8	-32.2 to -12.7
Hardness	17.5, 125, and 225 mg/L	-5.6 to 9.3	-17.4 to 2.3
Monochloramine	0.2, 1.2, 2.2 mg/L	12.7 to 28.4	<0.22 mg/L from reference
ORP	550 and 700 millivolts	-9.2 to 1.6	-5.7 to 8.4 (DW) -78.5 to -28.5 (SW and IPW)
pH	5.4, 7, 10 pH units	-0.25 to 0.21 (pH units)	-0.25 to 0.25 (pH units)
Overall Precision	Excluding the monochloramine results for the DW, out of 216 triplicate measurements, 16 (7.4%) had %RSDs of greater than 10%.		

Inter-unit Reproducibility	Out of 106 pairs of triplicate results using separate units, 19 pairs were determined to be significantly different from one another by a paired t-test. Most of these differences were relatively small, driven mostly by extremely small variability.
Field Portability	The difference between the average %D between the laboratory and field measurements in Stage 2 was small in most cases. In four out of 30 instances, the difference between average %Ds exceeded 10% and in each of those occurrences, the field results were closer to the reference measurement result than the laboratory result. For pH, the results determined at the laboratory did not differ by more than a pH of 0.11.
Operational Factors	Verification staff found the WP870 to be easy to use both in the laboratory setting, where most of the quantitative results were collected, and in the various field environments in which the WP870 was used. The WP870 procedure for calibration as well as measurement of samples includes the addition of either calibration solutions or water samples to the sample tube attached to the handheld unit. Overall, operators from both TCEQ and U.S. EPA NERL who performed field analyses considered it to be an easy-to-use instrument. However, the operators did note that the instrument is limited in that each sensor can analyze 50 samples over 30 days following initial calibration.

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