UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, D.C. 20460

ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM VERIFICATION STATEMENT

TECHNOLOGY TYPE:	**FIELD-PORTABLE GAS CHROMATOGRAPH**
APPLICATION:	**MEASUREMENT OF CHLORINATED VOLATILE ORGANIC COMPOUNDS IN WATER**
TECHNOLOGY NAME:	**Model 4100**
COMPANY ADDRESS:	**Electronic Sensor Technology** **1077 Business Center Circle** **Newbury Park, CA 91320**
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PROGRAM DESCRIPTION

The U.S. Environmental Protection Agency (EPA) created the Environmental Technology Verification Program (ETV) to facilitate the deployment of innovative environmental technologies through verification of performance and dissemination of information. The goal of the ETV program is to further environmental protection by substantially accelerating the acceptance and use of improved and cost-effective technologies. The ETV program is intended to assist and inform those involved in the design, distribution, permitting, and purchase of environmental technologies.

Under this program, in partnership with recognized testing organizations, and with the full participation of the technology developer, the EPA evaluates the performance of innovative technologies by developing demonstration plans, conducting field tests, collecting and analyzing the demonstration results, and preparing reports. The testing is conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible. The EPA's National Exposure Research Laboratory, in cooperation with Sandia National Laboratories, the testing organization, evaluated field-portable systems for monitoring chlorinated volatile organic compounds (VOCs) in water. This verification statement provides a summary of the demonstration and results for the Electronic Sensor Technology (EST) Model 4100 field-portable gas chromatograph (GC).

DEMONSTRATION DESCRIPTION

The field demonstration of the Model 4100 portable GC was held in September 1997. The demonstration was designed to assess the instrument's ability to detect and measure chlorinated volatile organic compounds in groundwater at two contaminated sites: the Department of Energy's Savannah River Site, near Aiken, South Carolina, and the McClellan Air Force Base, near Sacramento, California. Groundwater samples from each site were supplemented with performance evaluation (PE) samples of known composition. Both sample types were used to assess instrument accuracy, precision, sample throughput, and comparability to reference laboratory results. The primary target compounds at the Savannah River Site were trichloroethene and tetrachloroethene. At

McClellan Air Force Base, the target compounds were trichloroethene, tetrachloroethene, 1,2-dichloroethane, 1,1,2-trichloroethane, 1,2-dichloropropane, and *trans*-1,3-dichloropropene. These sites were chosen because they contain varied concentrations of chlorinated VOCs and exhibit different climatic and geologic conditions. The conditions at these sites are typical, but not inclusive, of those under which this technology would be expected to operate. A complete description of the demonstration, including a data summary and discussion of results, may be found in the report entitled *Environmental Technology Verification Report, Field-Portable Gas Chromatograph, Electronic Sensor Technology, Model 4100*. (EPA/600/R-98/141).

TECHNOLOGY DESCRIPTION

Gas chromatography is a proven analytical technology that has been used in environmental laboratories for many years. The Model 4100 GC incorporates a purge-and-trap sample introduction method for the analysis of VOCs in water. The instrument is a single-column GC with programmable temperature control and a surface acoustic wave detector. The system uses short, capillary GC columns and a fast-response detector to produce a complete chromatogram in 30 seconds or less. A room-temperature water sample is sparged with a small volume of air and the entrained VOCs are transferred to a small adsorbent trap, which is subsequently thermally desorbed and injected onto the GC column of the Model 4100. The chromatographic column separates the sample mixture into individual components. Compounds exiting the column momentarily stick to the detector surface, causing a frequency change in an oscillating crystal.

Compounds are identified by column retention time and are quantified by comparing detector response to that of standards run under similar conditions. A gas chromatograph offers some limited potential for identification of unknown components in a mixture; however, a confirmational analysis by an alternative method is often advisable. A field-portable GC is a versatile technique that can be used to provide rapid screening data or routine monitoring of groundwater samples. In many GC systems, the instrument configuration can also be quickly changed to accommodate different sample matrices such as soil, soil gas, water, or air. As with all field analytical studies, it may be necessary to send a portion of the samples to an independent laboratory for confirmatory analyses.

The Model 4100 weighs 35 pounds and is about the size of a large briefcase. The unit can be easily transported and operated in the rear compartment of a minivan. Instrument detection levels for many chlorinated VOCs in water range from 10 to 100 µg/L. Sample processing and analysis can be accomplished by a chemical technician; however, instrument method development, instrument calibration, and data processing may require a higher level of operator experience and training. At the time of the demonstration, the baseline cost of the Model 4100 with laptop computer was $25,000.

VERIFICATION OF PERFORMANCE

The following performance characteristics of the Model 4100 were observed:

Sample Throughput: Throughput was approximately two to three water samples per hour. This rate includes the periodic analysis of blanks and calibration check samples.

Completeness: The Model 4100 reported results for all of the 165 PE and groundwater samples provided for analysis at the two demonstration sites.

Analytical Versatility: The Model 4100 was calibrated for and detected 25 of the 32 (78%) PE sample VOCs provided for analysis at the demonstration. Six pairs of coeluting compounds were reported. For the groundwater contaminant compounds for which it was calibrated, the Model 4100 detected 42 of the 66 compounds detected by the reference laboratory at concentration levels in excess of 1 µg/L. A total of 68 compounds were detected by the reference laboratory in all groundwater samples.

Precision: Precision was determined by analyzing sets of four replicate samples from a variety of PE mixtures containing known concentrations of chlorinated organic compounds. The results are reported in terms of a

relative standard deviation (RSD). The distribution of RSD values compiled for all reported compounds from both sites had a median value of 15% and a 95th percentile value of 46%. By comparison, the compiled RSDs from the reference laboratory had a median value of 7% and a 95th percentile value of 25%. The ranges of Model 4100 RSD values for specific target compounds were as follows: trichloroethene, 2 to 28% (reported as coeluter with 1,2-dichloropropane); tetrachloroethene, 6 to 22%; 1,2,3-trichloropropane, 4 to 41%; and *trans*-1,3-dichloropropene, 4 to 55%.

Accuracy: Instrument accuracy was evaluated by comparing Model 4100 results with the known concentrations of chlorinated organic compounds in PE mixtures. Absolute percent difference (APD) values from both sites were calculated for all analytes in the PE mixtures. The APDs for all reported compounds from both sites had a median value of 44% and a 95th percentile value of 100%. By comparison, the compiled APDs from the reference laboratory had a median value of 7% and a 95th percentile value of 24%. The ranges of Model 4100 APD values for target compounds were as follows: trichloroethene, 25 to 42% (reported as coeluter with 1,2-dichloropropane); tetrachloroethene, 32 to 66%; 1,2-dichloroethane, 2 to 20%; 1,2,3-trichloropropane, 12 to 74%; 1,1,2-trichloroethane, 8 to 43%; and *trans*-1,3-dichloropropene, 2 to 45%.

***Comparability*:** A comparison of Model 4100 and reference laboratory data was based on 33 groundwater samples analyzed at each site. The correlation coefficients (r) for all compounds detected by the Model 4100 and laboratory, at or below the 100 µg/L concentration level, were 0.967 at Savannah River and 0.816 at McClellan. The r values for compounds detected at concentration levels in excess of 100 µg/L were 0.969 for Savannah River and 0.968 for McClellan. These correlation coefficients reveal a highly linear relationship between Model 4100 and laboratory data. The median absolute percent difference between groundwater compounds mutually detected by the Model 4100 and reference laboratory was 30%, with a 95th percentile value of 100%.

Deployment: The system was ready to analyze samples within 30 minutes of arrival at the site. At both sites, the instrument was transported in a minivan and operated from its rear compartment. The instrument was powered with line ac obtained from a small dc-to-ac inverter connected to the vehicle's battery.

Under appropriate applications, the Model 4100 field-portable gas chromatograph with surface acoustic wave detector can provide useful, cost-effective data for environmental site characterization and routine monitoring. The results of this demonstration show that the instrument is best suited for routine monitoring of water samples contaminated with relatively few chlorinated VOCs. In the selection of a technology for deployment at a site, the user must determine what is appropriate through consideration of instrument performance and the project's data quality objectives.

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