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

ETV✓

ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM
VERIFICATION STATEMENT

TECHNOLOGY TYPE:	**FIELD-PORTABLE GAS CHROMATOGRAPH**
APPLICATION:	**MEASUREMENT OF CHLORINATED VOLATILE ORGANIC COMPOUNDS IN WATER**
TECHNOLOGY NAME:	**Voyager**
COMPANY ADDRESS:	**Perkin-Elmer Corporation - Photovac Monitoring Instruments** **50 Danbury Road** **Wilton, CT 06897**
PHONE:	**(203) 761-2557**

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 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 Perkin-Elmer Photovac, Voyager field-portable gas chromatograph (GC).

DEMONSTRATION DESCRIPTION

The field demonstration of the Voyager portable GC was held in September 1997. The demonstration was designed to assess the instrument's ability to detect and measure chlorinated VOCs 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 geological 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, Perkin-Elmer Photovac, Voyager*. (EPA/600/R-98/144).

TECHNOLOGY DESCRIPTION

Gas chromatography with electron capture detection is a proven analytical technology that has been used in environmental laboratories for many years. The gas chromatographic column separates the sample into individual components. The electron capture detector measures a change in electron current from a sealed radioactive source as compounds exit the chromatographic column, move through the detector, and capture electrons. The electron capture detector is particularly sensitive to chlorinated compounds. Compounds are identified by matching the column retention time of sample components, run under controlled temperature conditions, to those of standard mixtures run under similar conditions. Quantitation is achieved by comparing the detector response intensity of the sample component and the standard. A GC offers some potential for identification of unknown components in a mixture; however, a confirmational analysis by an alternative method is often advisable. 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 Voyager includes an on-board processor and is encapsulated in a weather-resistant case. The GC unit weighs about 15 pounds and the accessories for water analysis weigh about 33 pounds. Both units can be easily transported and operated in the rear compartment of a minivan. The instrument utilizes an equilibrium headspace technique for the analysis of VOCs in water. Instrument detection limits for many chlorinated VOCs in water are in the range of 5 to 10 µg/L. Sample processing and analysis can be accomplished by a chemical technician with 1 day of training; however, instrument method development and initial calibration may require additional experience and training. At the time of the demonstration, the baseline cost of the Voyager and headspace sampling accessories was $24,000. Operational costs, which take into account consumable supplies, are on the order of $25 per 8-hour day.

VERIFICATION OF PERFORMANCE

The following performance characteristics of the Voyager were observed:

Sample Throughput: Throughput was one to three samples per hour. This rate includes the periodic analysis of blanks and calibration check samples. The sample throughput rate is influenced by the complexity of the sample, with less complex samples yielding higher throughput rates.

Completeness: The Voyager reported results for all 166 PE evaluation and groundwater samples provided for analysis at the two demonstration sites.

Analytical Versatility: The Voyager was calibrated for and detected 75% (24 of 32) of the PE sample VOCs provided for analysis at the demonstration. Three pairs of coeluting compounds were encountered in the GC methods used during this demonstration. For the groundwater contaminant compounds for which it was calibrated, the Voyager detected 39 of the 44 compounds reported 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 VOCs. The results are reported in terms of relative standard deviations (RSD). The RSDs compiled for all reported compounds from both sites had a median value of 20% and a 95th percentile value of 69%. By comparison, the compiled RSDs from the reference laboratory had a median value of 7% and a 95th percentile value of 25%. The range of Voyager RSD values for specific target compounds was as follows: trichloroethene, 7 to 71%; tetrachloroethene, <30% (limited data—-only one value was available); 1,2-dichloroethane and 1,2-dichloropropane (coeluting pair), 4 to 44%; 1,1,2-trichloroethane, 11 to 103%; and *trans*-1,3-dichloropropene, 8 to 46%.

Accuracy: Instrument accuracy was evaluated by comparing Voyager results with the known concentrations of chlorinated organic compounds in PE mixtures. Absolute percent difference (APD) values from both sites were calculated for all reported compounds in the PE mixtures. The APDs from both sites had a median value of 41% and a 95th percentile value of 170%. By comparison, the compiled APDs from the reference laboratory had a median value of 7% and a 95th percentile value of 24%. The range of Voyager APD values for target compounds was as follows: trichloroethene, 8 to 244%; tetrachloroethene, 24 to 99%; 1,2-dichloroethane and 1,2-dichloropropane (coeluting pair), 14 to 70%; 1,1,2-trichloroethane, 16 to 50%; and *trans*-1,3-dichloropropene, 3 to 62%.

Comparability: A comparison of Voyager and reference laboratory data was based on 33 groundwater samples analyzed at each site. The correlation coefficient (r) for all compounds detected by both the Voyager and the laboratory at or below the 100 µg/L concentration level was 0.890 at Savannah River and 0.660 at McClellan. The r values for compounds detected at concentration levels in excess of 100 µg/L were 0.830 for Savannah River and 0.999 for McClellan. These correlation coefficients reveal a moderately linear relationship between Voyager and laboratory data. The median absolute percent difference between groundwater compounds mutually detected by the Voyager and reference laboratory was 74%, with a 95th percentile value of 453%.

Deployment: The system was ready to analyze samples within 60 minutes of arrival at the site. At both sites, the instrument was transported in and operated from the rear luggage compartment of a minivan. The instrument was powered by self-contained batteries or from a small dc-to-ac inverter connected to the vehicle's battery.

The results of the demonstration revealed that sample handling methodologies may have adversely affected the observed precision and accuracy of the instrument. Perkin-Elmer Photovac has developed an improved field method for sample preparation and handling that includes the use of an internal standard. The new method is expected to result in improved instrument precision and accuracy. The Voyager may be suitable for both field screening and routine analysis applications. In the selection of a technology for use at a particular site, the user must determine what is appropriate through consideration of instrument performance and the project's data quality objectives.

Gary J. Foley, Ph. D.
Director
National Exposure Research Laboratory
Office of Research and Development

Samuel G. Varnado
Director
Energy and Critical Infrastructure Center
Sandia National Laboratories

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