

GEOPROBE SYSTEMS

(Large Bore Soil Sampler)

TECHNOLOGY DESCRIPTION:

The Large Bore Soil Sampler is a single tube-type, solid barrel, closed-piston sampler (see figure below). It is designed to be driven by the Geoprobe percussion probing machine to collect discrete interval soil samples but can be used for continuous coring if needed. This direct push type sampler is for use in unconsolidated soils. It is capable of recovering a soil core 22 inches long by 1-1/16 inches in diameter (320 milliliter (mL) volume). A liner is inserted inside the sampler body to retain the sample after collection and to facilitate removal from the sampler body. Liner materials are available in brass, stainless steel, teflon, and clear plastic

(cellulose acetate butyrate).

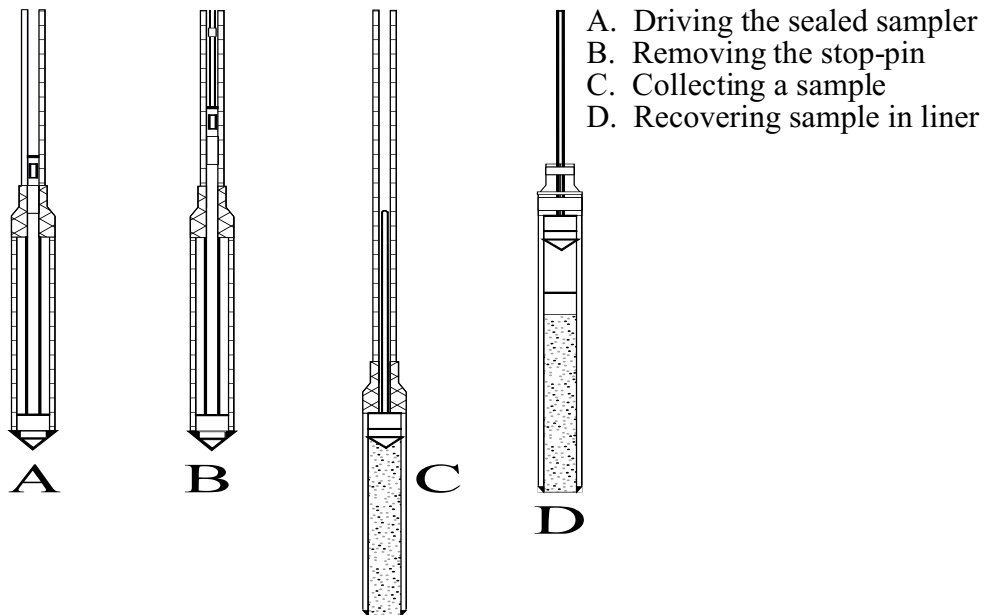
WASTE APPLICABILITY:

The Large Bore Soil Sampler can be used to collect soil samples for both organic and inorganic analytes when appropriate liner materials are used. The sampler has been used to collect samples to be analyzed for herbicides, pesticides, polychlorinated biphenyls (PCBs), semivolatile organic compounds, aromatic and halogenated volatile organic compounds (VOCs), petroleum fuels, metals, nitrates, dioxins and furans.

STATUS:

Geoprobe's Large Bore Soil Sampler was demonstrated under the SITE program during the early summer of 1997. The demonstration results indicate that the Large-Bore Soil Sampler can provide useful, cost-effective samples for environmental problem solving. However, in some cases, VOC data collected using the Large Bore Soil Sampler may be statistically different from VOC data collected using the reference sampling method. Also, the integrity of a lined sample chamber may not be preserved when the sampler is advanced through highly contaminated zones in clay soils. Demonstration results are documented in the "Environmental Technology Verification" report for the sampler dated August 1998 (EPA/600/R-98/092).

There are several hundred Geoprobe owner/operators who use the Large Bore Soil Sampler for geo-environmental investigations. This soil sampler has been used in all 50 states and several foreign countries to complete thousands of projects. It is used primarily for geo-environmental investigations to define soil types and delineate contaminant distribution. The Large Bore Soil Sampler is available in stock from Geoprobe Systems. Geoprobe has developed other soil and groundwater sampling tools that are also widely used in the geo-environmental field.



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GEOPROBE SYSTEMS

(Geoprobe Soil Conductivity Sensor)

TECHNOLOGY DESCRIPTION:

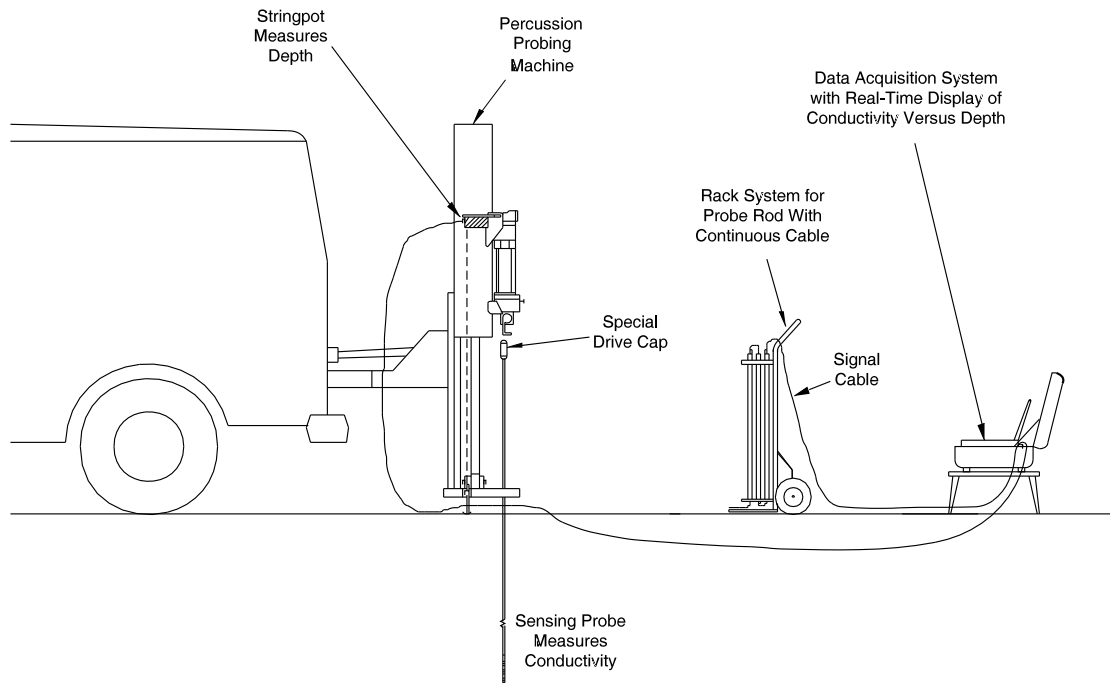
The Geoprobe soil conductivity sensor, shown in the figure below, identifies lithology and potential contamination by measuring the electrical conductivity of soil and hydrogeologic fluids. Soils vary in their electrical conductivity depending on particle size; for example, clays and silts generally have high conductivities, while sand and gravels exhibit low conductivities. Overall, soil and rock are resistant to current. Pore fluids and the amount of dissolved solids in these fluids also influence soil conductivity.

The Geoprobe conductivity sensor uses an isolated array of sensing rings to measure this conductivity. The sensor is principally designed to help determine subsurface stratigraphy. The sensor may also help characterize subsurface contamination, especially where high conductivity leachates or brines are involved.

The principal components of the complete Geoprobe system are as follows:

- A Geoprobe hydraulic soil probing machine
- Standard sampling rods supplied with the system
- A cable, threaded through the sampling rod that introduces the current
- The conductivity sensor
- A data receiver connected to a personal computer to record the sensor's measurements

The hydraulic probing machine uses a combination of pushing and hammering to advance 3-foot-long segments of 2.54-centimeter-diameter hollow steel sampling rods. The conductivity sensor is attached to the lead section of the sampling rod.



Schematic Diagram of the Geoprobe Soil Conductivity Sensor

The conductivity sensor consists of four stainless-steel contact rings fitted around a central steel shaft. Plastic electronically isolates the contact rings from the steel shaft. A hollow steel rod extends above the uppermost stainless steel ring, housing a shielded signal cable that connects the contact rings with an external power source, measurement system, and data logging system. The soil conductivity sensor can be used in a dipole array or a Schlumberger array. The dipole array is used when greater resolution is required. The Schlumberger array is generally used when optimal soil-to-probe contact cannot be maintained.

WASTE APPLICABILITY:

The Geoprobe conductivity sensor is designed to determine subsurface stratigraphy. Only highly conductive contaminants such as oil field brine can be directly measured by the sensor.

STATUS:

The Geoprobe conductivity sensor field demonstration was conducted in September 1994. The report is available.

Improvements to the unit include the availability of stronger 1.25-inch diameter probe rods, more durable probes, dipole-type probes used for dipole measurements, and expendable probes for use when grouting is required.

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GRASEBY IONICS, LTD., and PCP, INC.

(Ion Mobility Spectrometry)

TECHNOLOGY DESCRIPTION:

Ion mobility spectrometry (IMS) is a technique used to detect and characterize organic vapors in air. IMS involves the ionization of molecules and their subsequent temporal drift through an electric field. Analysis and characterization are based on analyte separations resulting from ionic mobilities rather than ionic masses; this difference distinguishes IMS from mass spectrometry. IMS operates at atmospheric pressure, a characteristic that has practical advantages over mass spectrometry, allowing a smaller analytical unit, lower power requirements, lighter weight, and easier use. These factors may facilitate use of IMS for mobile, field applications.

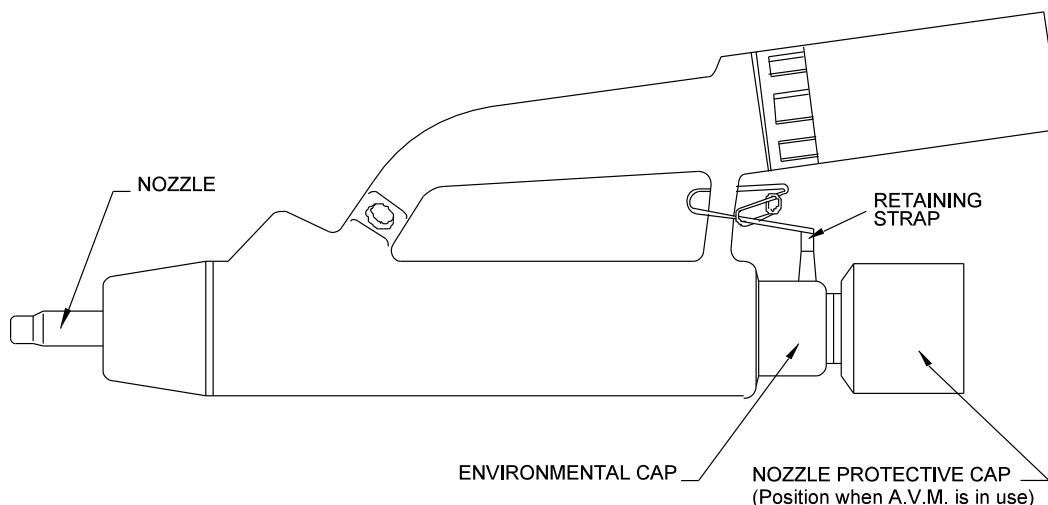
WASTE APPLICABILITY:

The IMS units, which are intended to be used in a preprogrammed fashion, can monitor chloroform, ethylbenzene, and other volatile organic compounds in a defined situation. IMS units can analyze air, vapor, soil, and water samples. However, for analysis of liquid and solid materials, the contaminants must be introduced to the instrument in the gas phase, requiring some sample preparation.

STATUS:

Graseby Ionics, Ltd. (Graseby), and PCP, Inc. (PCP), participated in a laboratory demonstration in 1990. Graseby used a commercially available, self-contained instrument that weighs about 2 kilograms (kg) (see figure below). PCP used a larger (12 kg) transportable IMS. This laboratory demonstration was the first opportunity to test the instruments on environmental samples. The demonstration results highlighted that the following needs must be satisfied before IMS is ready for field applications:

- Additional development of sampling or sample preparation strategies for soil and water analysis.
- Improvements in the design and performance of IMS inlets, in conjunction with the development of sampling and presentation procedures.



Airborne Vapor Monitor for IMS

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HANBY ENVIRONMENTAL LABORATORY PROCEDURES, INC.

(Test Kits for Organic Contaminants in Soil and Water)

TECHNOLOGY DESCRIPTION:

Hanby Environmental Laboratory Procedures, Inc. (H.E.L.P.), field test kits for soil and water (as shown in the figure below) provide rapid, sensitive analyses for a broad range of organic contaminants. The kits have been used at spill and leak sites for petroleum substances including fuels, solvents, oils, pesticides, herbicides, and indirectly wood preservatives such as pentachlorophenols (PCP). The test kit methods are based on simple extraction and colorimetric procedures using Friedel-Crafts (F-C) chemical reactions. During analyses for PCPs suspended in diesel fuel carrier solvent, where the actual analyte does not undergo F-C reactions, it is necessary to perform other analyses to determine the ratio of the target compound to the detected carrier solvent. At locations where the type of contaminant is known, such as gasoline or diesel fuel sites, the appropriate calibration photograph for the substance is used which provides precise quantitative analytical information. Alternatively, H.E.L.P. provides a portable spectrophotometer which reads the sample results, identifying a wider variety of chemicals.

The test kits provide the equipment and reagents to perform 15 soil or water samples. Soil tests are performed using the following steps:

- Using the electronic balance, weigh 5 grams of soil into a beaker.
- Empty one solvent ampule into the beaker.
- Stir the sample for 2 minutes (extraction).
- Pour extract from the beaker into one of the sample test tubes.
- Empty one catalyst powder vial into the test tube, cap and shake for 3 minutes.
- Compare the developed color of the sample to the appropriate calibration photograph, or insert the test tube into the spectrophotometer for readout.

Water testing is performed in a similar manner, except that the extraction procedure is performed on a 500-milliliter water sample in a separatory funnel which comes with the water test kit.



Hanby Test Kit

WASTE APPLICABILITY:

H.E.L.P. field test kits analyze aromatic, halogenated, and other compounds which participate in F-C reactions. These compounds include the complete range of fuel types such as gasoline, diesel fuel, and jet fuel, as well as all types of crude oils. The test kits are also used for the measurement of many other types of substances such as new and used motor oils, transformer oils, hydraulic fluids, and other types of organic liquids which contain only small amounts of F-C reacting compounds. The intense color of these reactions allows sensitivities of detection from 1 to 25 parts per million (ppm).

The availability of two solvent types for the kits provides a range from 1 ppm (with the lower range solvent) to 100,00 ppm (with the high range solvent). The H.E.L.P. test kit was used to indirectly screen and quantify PCP contamination in soils for a SITE demonstration in Morrisville, North Carolina in August 1993, using samples collected from a wood preserving site in Winona, Missouri. These samples contained PCP in a diesel carrier solvent. When the ratio of carrier solvent to PCP was constant, the PCP concentration data obtained using the H.E.L.P. test kit correlated well with sample splits analyzed at an off-site laboratory. Results from the demonstration have been published in an Innovative Technology Evaluation Report (EPA/540/R-95/514), which is available from EPA.

The field test kits and the associated spectrophotometer, the H.E.L.P. MATE 2000, were selected by the U.S. Department of Commerce and EPA Rapid Commercialization Initiative (RCI) as representative of "best available demonstrated technology" in March 1996. The technologies selected for RCI was demonstrated and assessed by EPA, the U.S. Departments of Energy, Commerce, and Defense, the California EPA, the Western Governor's Association, and the Southern States Energy Board throughout 1996 and 1997.

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HEWLETT-PACKARD COMPANY

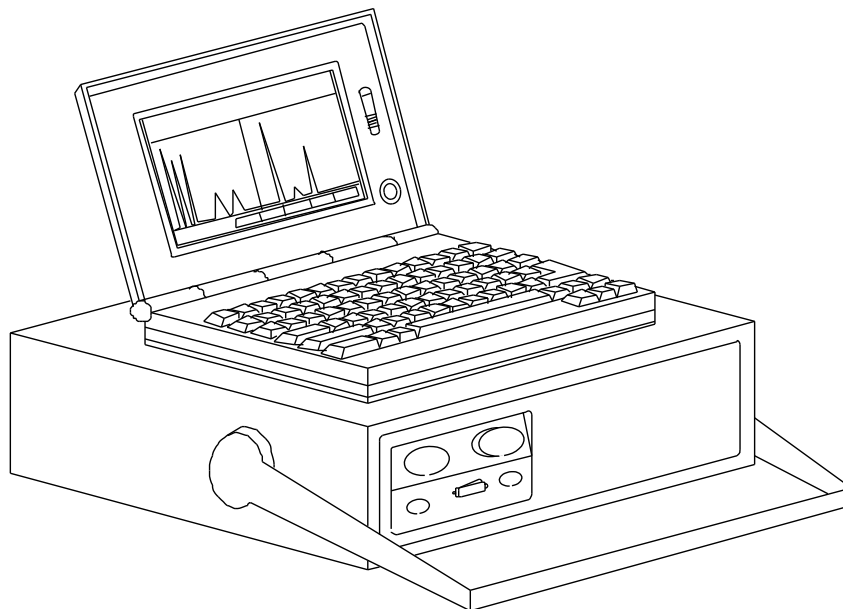
(via acquisition of MTI Analytical Instruments, Inc.)
(Portable Gas Analyzer/HP Micro GC)

TECHNOLOGY DESCRIPTION:

The Hewlett-Packard (HP) portable gas analyzer, shown below, is a multi-channel, high-speed, portable micro gas chromatograph (GC) that provides isothermal analysis of gas-phase samples. The injector and thermal conductivity detector (TCD) are micro-electromechanical systems (MEMS). That is, they are fabricated from silicon using micro-machining techniques similar to that used to produce microprocessors, microcircuits, etc. As a result these chromatographic components are extremely small and exhibit extremely high reliability and performance. Depending on the analysis requirements, these two components are combined with one of a series of high performance/microbore capillary columns (ranging from 0.25 to 14 meters in length and 0.150-0.32 mm inside diameter [ID]) into an individually programmable analysis channel. Up to four independent, optimized analyses (separations) of a single gas sample can be performed simultaneously in a single instrument.

A gas sample is drawn into a sample loop with an internal vacuum pump. An aliquot of the sample is then introduced into the capillary column using the microvalves contained within the micro-machine injector. The maximum analysis time for components up to C10 is 160 seconds or less, making the HP Micro kGC one of the fastest commercially available gas chromatographs.

The HP portable gas analyzer houses an internal sealed lead acid battery and small refillable carrier gas cylinder providing up to 8 hours of continuous operation. When combined with a laptop computer and instrument control/data analysis software, the HP portable gas analyzer is fully capable of field operation.



P200 Gas Analyzer

WASTE APPLICABILITY:

The HP portable gas analyzer can detect many volatile organic compounds (VOC) at concentrations as low as 1 ppm. A heated sample inlet system enables the gas analyzer to detect higher boiling compounds like naphthalene and hexachlorobutadiene. When combined with an air sampler/pre-concentrator (ex. Entech, Tekmar/Dohrmann) detection limits in the range of 1 to 10 parts per billion for EPA Method TO-14 compounds can be obtained.

The HP portable gas analyzer can be employed for the analysis of soil gases, VOC contaminants in groundwater, and, with the use of an air sampler/pre-concentrator device, VOCs in ambient air. The micro TCD is suitable for analyzing many types of organic and inorganic vapor-phase compounds. The HP portable gas analyzer can be used as part of a system to monitor VOC emissions from hazardous waste sites as part of first site assessment activities and as part of a remediation program. Because of its portability, high analytical speed, and relatively low detection limit, the gas analyzer provides results of comparable quality to laboratory based analysis instruments, including gas chromatography/mass spectrometry (GC/MS).

STATUS:

The P200 gas analyzer was evaluated during a field study in August 1995. During the study, downwind vapors from an artificial source generator were analyzed. Preliminary results of the demonstration were presented in an article titled "Performance Comparison of Field-Deployable Gas Chromatographs with Canister TO-14 Analyses" in the *Proceeding of the 1996 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-64, 1996.

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HNU SYSTEMS, INC.

(HNU GC 311D Portable Gas Chromatograph)

TECHNOLOGY DESCRIPTION:

The field-deployable HNU GC 311D portable gas chromatograph monitors a wide range of compound emissions from hazardous waste sites and other emissions sources before and during remediation (see photograph below). It has an internal carrier gas supply, operates on 110-volt line power, is microprocessor-controlled, and is temperature programmable. An internal printer plots chromatograms and prints data. Data can also be reported to an external computer, which is connected through an RS-232 outlet.

The instrument has simultaneous dual-detector capability and allows the user to choose from four interchangeable detectors: photoionization, flame ionization, electron-capture, and far ultraviolet absorbance. Capillary columns of all sizes can be installed. The instrument is capable of autosampling. The HNU GC 311D is applicable to a wide variety of vapor-phase pollutants.

The photoionization detector is sensitive to compounds that ionize below 11.7 electron volts, such as aromatic compounds and unsaturated halocarbons. The flame ionization detector is sensitive to hydrocarbons. The electron-capture detector is sensitive to halocarbons and polychlorinated biphenyls. The far ultraviolet absorbance is a universal detector with characteristics similar to that of a thermal conductivity detector (TCD).

STATUS:

The instrument was evaluated in January 1992 at a Superfund site under remediation. Results from the demonstration are presented in a peer-reviewed article entitled "Evaluation of Portable Gas Chromatographs" in the *Proceedings of the 1993 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-33, Volume 2, 1993. A final report will not be prepared.



HNU GC 311D Portable Gas Chromatograph

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HNU SYSTEMS, INC.
(HNU Source Excited Fluorescence
Analyzer-Portable [SEFA-P] X-Ray Fluorescence Analyzer)

TECHNOLOGY DESCRIPTION:

HNU Systems, Inc. developed the Source Excited Fluorescence Analyzer - Portable (SEFA-P), a portable X-ray technology, to selectively determine metals concentrations in soils and other media at hazardous waste sites or industrial locations. Three excitation sources are offered with the SEFA-P X-ray fluorescence (XRF) Analyzer: Iron-55, Cadmium-109, and Americium-241. The SEFA-P is shown in the photograph below.

The SEFA-P in its most basic form consists of the following components: one main cabinet that encloses the sample chamber; the excitation sources; a liquid nitrogen-cooled Si(Li) detector; a preamplifier; spectrometer electronics; a multi-channel analyzer (MCA); and a battery charger. The internal battery can power the MCA for 8 hours. The MCA has an RS-232 interface that allows the SEFA-P to be externally controlled through a PC or laptop computer. The SEFA-P weighs approximately 50 pounds.



Source Excited Fluorescence Analyzer-Portable (SEFA-P) XRF Analyzer

The SEFA-P can be calibrated empirically or using the Compton ratio. Quantitative results for samples are displayed on the PC screen in units of parts per million. The SEFA-P only analyzes soil samples in the intrusive mode; soil samples are placed in sample cups prior to analysis. After calibrating the unit, analyzing quality control samples, and preparing samples, it is possible to analyze 30 to 50 samples in an 8- to 10-hour day.

The SEFA-P is sold with a general license, so the operator does not have to be specifically licensed in each state in which it is used. As of 1995, the SEFA-P retailed for approximately \$45,000, depending on the options included. This price includes one in-house operational training course.

WASTE APPLICABILITY:

The SEFA-P can detect elements from aluminum through uranium in soil or other media, such as those elements at mining and smelting sites, drum recycling facilities, or plating facilities. The instrument can provide real-time, on-site analytical results during field screening and remedial operations. XRF analysis is faster and more cost-effective compared to conventional laboratory analysis.

STATUS:

The SEPA-A has been used at a number of Superfund sites across the country. A SITE demonstration of the SEFA-P was conducted in February 1995 and summarized in Technical Report No. EPA/600/R-97/144, dated March 1998. The instrument was used to identify and quantify concentrations of metals in soils. The report gives field-based method detection limits, accuracy, and precision data from the analysis of standard reference materials and performance evaluation samples. Comparability of the XRF results to an EPA-approved reference laboratory method was also assessed. The draft fourth update to SW-846 includes Method 6200, dated January 1998, which incorporates the results of the SITE demonstration.

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HORIBA INSTRUMENTS, INC.
(Infrared Analysis)**TECHNOLOGY DESCRIPTION:**

The OCMA-350 developed by Horiba measures the oil content in water samples using infrared analysis. The OCMA-350 includes a single-beam, fixed-wavelength, nondispersive infrared filter-based spectrophotometer. Infrared radiation from a tungsten lamp is transmitted through a cylindrical, quartz cuvette containing a sample extract. The radiation that has passed through the extract enters a detector containing a filter that isolates analytical wavelengths in the 3400- to 3500-nanometer range.

During the demonstration, Horiba dried soil by adding anhydrous sodium sulfate. Extraction of petroleum hydrocarbons in a given soil sample was typically performed by adding 20 milliliters of Horiba's proprietary S-316 extraction solvent to 5 grams of the sample. The mixture was agitated using an ultrasonic mixer. The sample extract was decanted into a beaker through a filter-lined funnel, and then the filtrate was poured into a quartz cuvette. The cuvette was placed in the spectrophotometer, and the TPH concentration in milligrams per kilogram was read on the digital display. Periodically, Horiba recycled the extraction solvent using its model SR-300 solvent reclaimer.

WASTE APPLICABILITY:

The OCMA-350 provides an analysis of the oil content in water samples. It is also able to evaluate the capabilities of semiconductor fabrication and precision machinery cleaning equipment, evaluate the properties of industrial process oil and the residual oil of polishing materials, as well as wastewater that has been adulterated with silt, sludge, and other suspended particles.

STATUS:

In June 2000, the EPA conducted a field demonstration of the OCMA-350 and six other field measurement devices for TPH in soil. The performance and cost of the OCMA-350 were compared to those of an off-site laboratory reference method. A complete description of the demonstration and summary of its results are available in the "Innovative Technology Verification Report: Field Measurement Devices for Total Petroleum Hydrocarbons in Soil-Horiba Instruments Incorporated OCMA-350 Oil Content Analyzer" (EPA/600/R-01/089).



DEMONSTRATION RESULTS:

The method detection limit for the OCMA-350 was determined to be 15.2 mg/kg. Seventy-eight of 107 results used to draw conclusions regarding whether the TPH concentration in a given sampling area or sample type exceeded a specific action level agreed with those of reference method. Of 102 results used to measure measurement bias, 64 were biased low, 38 were biased high. For soil environmental samples, the results were statistically the same as the reference method for four of the five sampling areas. The OCMA-350 exhibited similar overall precision to the reference method (RSD ranges were 1.5 to 20 percent and 5.5 to 18 percent for the OCMA-350 and the reference method, respectively). The OCMA-350 showed no response for interferents such as PCE, 1, 2, 4-trichlorobenzene, and soil spiked with humic acid. The mean response for MTBE, Stoddard solvent, and turpentine were 72.5, 86, and 85 percent, respectively. The OCMA-350 showed a three-fold increase in TPH results when the moisture content for weathered gasoline samples was increased, and a three-fold decrease when the moisture content of diesel soil samples was increased. Both the measurement time and cost compared well with those of the reference method.

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IDETEK, INC.
(formerly BINAX CORPORATION, ANTOX DIVISION)
(Equate® Immunoassay)

TECHNOLOGY DESCRIPTION:

The Equate® immunoassay (see photograph below) uses an anti-benzene, toluene, and xylene (BTX) polyclonal antibody to facilitate analysis of BTX in water. A hapten-enzyme conjugate mimics free BTX hydrocarbons and competes for binding to the polyclonal antibody immobilized on a test tube. After the test tube is washed to remove unbound conjugate, a substrate chromogen mixture is added and a colored enzymatic reaction product forms. The enzymatic reaction is stopped by adding a few drops of sulfuric acid, which colors the enzymatic product yellow.

As with other competitive enzyme-linked immunosorbent assays, the color intensity of the enzymatic product is inversely proportional to the sample analyte concentration. Each sample is run with a reference sample of deionized water. The optical density of the colored enzymatic product is read on a portable digital colorimeter equipped with a filter that passes light at a peak wavelength of 450 nanometers. The ratio of the sample to the reference optical density values is used to estimate the aromatic hydrocarbon level in the low parts per million (ppm) range. The test is sensitive to about 1 ppm and requires 5 to 10 minutes per analysis.



Equate® Immunoassay Kit

WASTE APPLICABILITY:

The Equate[®] immunoassay is designed to measure BTX in water.

STATUS:

The National Exposure Research Laboratory-Las Vegas evaluated several versions of the Equate[®] immunoassay. The evaluation focused on cross-reactivity and interference testing and on analysis of benzene, toluene, ethylbenzene, and xylene and gasoline standard curves.

As a preliminary field evaluation, the Equate[®] immunoassay was used to analyze in duplicate five well samples and a creek sample, both in the field and the laboratory. Confirmatory analysis was conducted using purge-and-trap gas chromatography with an electron-capture detector, in parallel with a photoionization detector.

A SITE demonstration of the Equate[®] immunoassay was conducted in 1992. Results from this demonstration were published in June 1994 in an EPA report entitled "Superfund Innovative Technology Evaluation (SITE) Program Evaluation Report for Antox BTX Water Screen (BTX Immunoassay)" (EPA/540/R-93/518).

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METOREX, INC.
(Field Portable X-Ray Fluorescence Analyzers)**TECHNOLOGY DESCRIPTION:**

Metorex, Inc. (Metorex), manufactures, sells, leases, and provides analytical and repair services for its X-MET line of field portable X-ray fluorescence (FPXRF) analyzers. The latest X-MET models in this series of instruments are the X-MET 920 and X-MET 2000 systems. The X-MET 920 series includes the X-MET 920-P and 920-MP. The X-MET analyzers are specifically calibrated for on-site or in situ hazardous waste analysis. These analyzers provide rapid, nondestructive measurements of inorganic contaminants in soil, thin film such as lead in paint, or water matrices.

Each X-MET 920 series analyzer is built from modules into systems based on customers' analytical and logistical needs. The X-MET PC System (XPCS) can either be built into the expansion slot of the computer or is provided as a standalone, battery-operated XPCS module for direct interface to a computer's RS-232 port.

The X-MET 920-P is equipped with either a solid state Si(Li) gas-filled proportional counter detector or the other new SIPS detector contained in a hand-held probe. The X-MET 920 MP is equipped with a gas-filled proportional counter detector contained in a hand-held probe.

The 920 X-MET, equipped with a Si(Li) detector, dual radioisotope sources, and a portable sealed computer, sells for \$47,950. The X-MET 920 MP sells for \$36,325 and the X-MET 2000 sells for \$62,430. These prices include factory training for two people at the Metorex facility. The X-MET can also be leased from Metorex.

The basic analyzer configuration includes the PC, XRF software, XPCS, and the analysis probe with excitation source. The XPCS contains a 2,048-channel multichannel analyzer that collects, analyzes, and displays the X-ray pulse-height spectrum. The high-resolution Si(Li) detector is liquid-nitrogen cooled by a 0.5-liter dewar built into the probe. The gas-filled proportional detector and SIPS intrinsic silicon pin diode detector operates at ambient temperatures. Metorex offers iron-55, cadmium-109, and americium-241 radioisotope excitation sources. Dual source configurations are available.

The X-MET 940 was tested as a prototype, which evolved into the X-MET 2000. It is essentially the same instrument as the X-MET 920-P but has a smaller, lighter physical configuration.

The X-MET 2000 is a custom, miniaturized, field-hardened, battery-operated, DOS-based computer that is dedicated to field XRF application. The system uses a flash or electronic hard disk to provide extreme durability under field operating conditions. It is among the smallest, lightest commercially available FPXRF with the full range of analytical capabilities.

All software is menu driven. These instruments are factory-calibrated and can be field-calibrated using either empirical calibration (all probes) or standardless-fundamental parameters (FP). For the Si(Li) probe, empirical calibration requires a set of site-typical or analyzed site-specific samples for the initial calibration. FP calibration requires one certified standard. Metorex claims that 50 or more soil samples can be analyzed in an 8- to 10-hour day with intrusive sampling, rigorous sample preparation, and long measurement times (200 to 300 seconds per sample) and up to 200 samples per day with in situ screening and short (10 to 100 seconds per sample) measurement times. The 920 X-MET, equipped with a Si(Li) detector, dual radioisotope sources, and a portable sealed computer, sells for \$47,950. The X-MET 920 MP sells for \$36,325 and the X-MET 2000 sells for \$62,430. These prices include factory training for two people at the Metorex facility. The X-MET can also be leased from Metorex.

WASTE APPLICABILITY:

The X-MET 2000 technology is designed to identify more than 60 elements in soil or other matrices, such as those at mining and smelting sites, drum recycling facilities, or plating facilities. The instrument can provide real-time, on-site analytical results during field screening and remediation operations. FPXRF analysis is faster and more cost-effective compared to conventional laboratory analysis.

STATUS:

The X-MET 920-P, 920-MP, and 940 were evaluated under the SITE Program in April 1995. The evaluation is summarized in technical reports EPA/600/R-97/146 for the 920-P and 940 and EPA/600/R-97/151 for the 920-MP, both dated March 1998. The instruments were used to identify and quantify concentrations of metals in soils. Evaluation of the results yielded field-based method detection limits, accuracy, and precision data from the analysis of standard reference materials and performance evaluation samples. Comparability of the FPXRF results to an EPA-approved reference laboratory method was also assessed. The draft fourth update to SW-846 includes Method 6200, dated January 1998, which incorporates the results of the SITE study.

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MICROSENSOR SYSTEMS, INCORPORATED
(MSI-301A Vapor Monitor)

TECHNOLOGY DESCRIPTION:

The MSI-301A vapor monitor is a portable, temperature-controlled gas chromatograph with a highly selective surface acoustic wave detector and an on-board computer (see photograph below). The MSI-301A vapor monitor performs the following functions:

- Preconcentrates samples and uses scrubbed ambient air as a carrier gas
- Analyzes a limited group of preselected compounds, such as benzene, toluene, and xylenes, at part per billion levels
- Operates by battery and includes an RS-232 interface

- Operates automatically as a stationary sampler or manually as a mobile unit

WASTE APPLICABILITY:

The MSI-301A vapor monitor can monitor many volatile organic compound emissions from hazardous waste sites and other sources before and during remediation. Some specific applications of the microsensor technology include OSHA compliance monitoring, environmental ambient air analysis, carbon bed breakthrough analysis, and industrial manufacturing area emission monitoring.



MSI-301A Vapor Monitor

STATUS:

In January 1992, the MSI-301A vapor monitor was evaluated in the field at a Superfund site. Results from the demonstration are presented in a peer-reviewed article entitled "Evaluation of Portable Gas Chromatographs" in the *Proceedings of the 1993 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-33, Volume 2, 1993.

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MILLIPORE CORPORATION (EnviroGard™ PCP Immunoassay Test Kit)

TECHNOLOGY DESCRIPTION:

The EnviroGard™ pentachlorophenol (PCP) immunoassay test kit, shown in the photograph below, rapidly analyzes soil and water samples at sites contaminated with PCP. The procedure is performed by adding a water or soil sample extract to test tubes coated with a specific antibody along with a PCP-enzyme conjugate. The PCP from the sample and the enzyme conjugate compete for immobilized anti-PCP antibody binding sites. After the initial competitive reaction, any unbound enzyme conjugate is washed from the tubes and a clear substrate is added. Any bound enzyme conjugate colors the clear substrate blue. A small portable photometer is used to measure the color intensity, which is inversely related to the concentration of the PCP in the original sample or calibrator solution.

The amount of color in the sample tubes is compared to calibrators corresponding to either 10 and 100 parts per million (ppm) for soil samples or 5 and 50 parts per billion (ppb) for water samples. Different detection levels can be achieved by diluting either the soil sample extract or the water sample.

The test kit has been tested for interferences with humic acids, pH, water content in soil samples, and oil co-contamination. Humic acid content in sample extracts greater than 10,000 ppb may cause false positive results. Samples with pH within the range of 4 to 14 were found to be correctly evaluated. The test kit correctly evaluated soils containing water up to 30 percent by weight, as well as samples containing water up to 10 percent by weight. Soil samples containing up to 10 percent oil were also correctly evaluated by the test kit.



EnviroGard™ PCP Immunoassay Test Kit

WASTE APPLICABILITY:

The EnviroGard™ PCP test kit measures PCP in water samples and extracts of soil samples. Detection limits are 10 ppm for soil samples and 5 ppb for water samples.

STATUS:

The EnviroGard™ PCP test kit was used to screen and quantify PCP contamination in soil and groundwater during a SITE demonstration in Morrisville, North Carolina in August 1993. The PCP carrier used at this site was a mixture of isopropyl ether and butane. In addition, soil and groundwater samples collected from a wood-preserving site in Winona, Missouri were tested during the demonstration. Diesel fuel was used as the PCP carrier at this site.

The test kit did not meet acceptable accuracy requirements during the demonstration. Millipore has since developed a revised protocol for PCP analysis. Millipore believes the revised protocol improves the accuracy and reproducibility of the test.

The Innovative Technology Evaluation Report (EPA/540/R-95/514), which details results from the demonstration, is available from EPA.

The EnviroGard™ PCP test kit has been accepted by the EPA Office of Solid Waste for inclusion in SW-846 as Method 4010A.

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NITON CORPORATION
(XL Spectrum Analyzer)

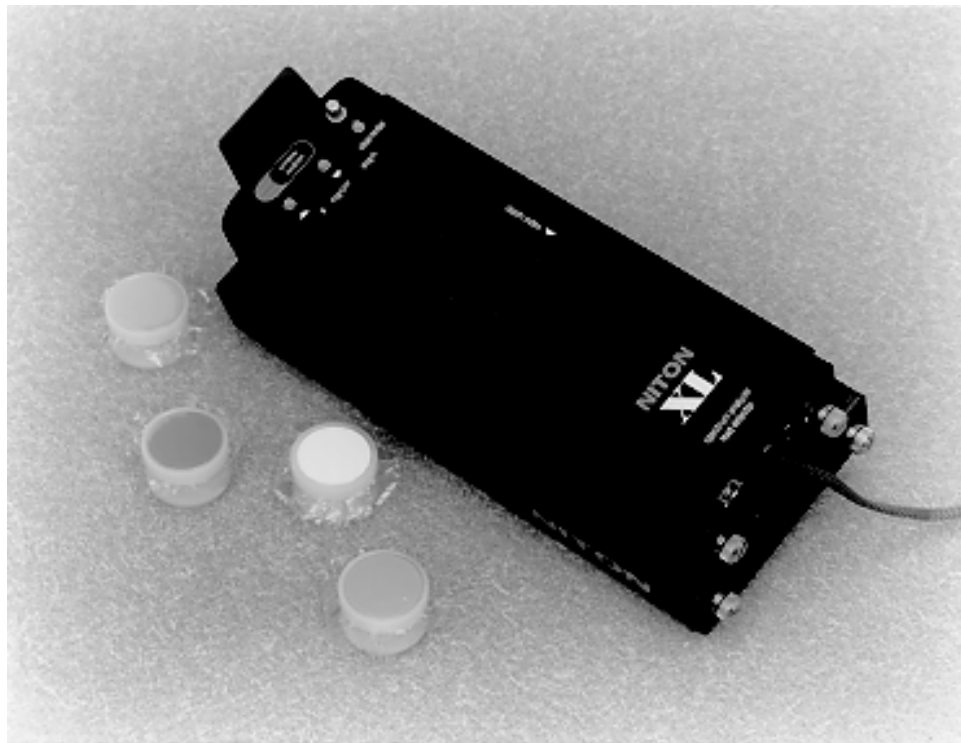
TECHNOLOGY DESCRIPTION:

NITON Corporation (Niton) manufactures and services the XL Spectrum Analyzer, the XL-309 Lead Detector, the XL-700 Series multi-element analyzers, and the XL-800 Series alloy analyzers. All are hand-held, field portable X-ray fluorescence (FPXRF) instruments.

The XL Spectrum Analyzer allows in situ and prepared-sample, on-site measurement of lead in paint, soils, dust wipes, coatings and air. Lead paint analysis is accepted by EPA, and NIOSH Method 7702 is in place for airborne lead analysis. The XL-700 Series is the multi-element analyzer. This instrument analyzes many elements, including all eight RCRA metals, in soils, filter media, and coatings (see photograph below).

The NITON XL-309 lead detector includes a cadmium-109 radioactive source (up to 40 millicurie) that provides the excitation energy that produces characteristic fluorescent X-rays from a sample. The XL-700 Series can be equipped with a cadmium-109 source, an Iron-55 source, an americium-241 source, or all three. All XL-309 instruments can be upgraded to any XL-700 Series instrument at any time. The XL-800 Series alloy analyzers are designed for rapid sorting and chemical identification of metal alloys and scrap metals.

The instrument includes a silicon Pin-diode detector (or a silicon diode plus cadmium-zinc-telluride detector for lead paint analysis), cooled by the thermoelectric Peltier effect. The instrument also includes (1) a multichannel analyzer of 1,024 channels, (2) an RS-232 serial port for data transfer and printing, (3) an internal memory for storing up to 1,000 readings with spectra, and (4) a back-lit graphic liquid crystal display.



XL Spectrum Analyzer

The instrument self-calibrates its energy scale and uses a Compton backscatter calibration technique for soil testing. The backscatter calibration compensates for X-ray absorption in the soil matrix. Alloy analysis is performed using fundamental parameters. The instrument is equipped with a removable lithium ion rechargeable battery that provides up to 8 hours of continuous use. It can analyze 20 to 25 samples per hour, based on a 60-second analysis time and minimal sample preparation.

The complete instrument, shown in the photograph above, weighs less than 3 pounds. NITON requires a 1-day operator training and radiation safety course which is offered at no charge. The course awards a certification maintenance point to Certified Industrial Hygienists who attend. NITON manufactures the Spectrum Analyzers under both general and specific licenses with the State of Rhode Island.

Instrument costs range between \$14,000 and \$37,000, depending on number of applications and radioactive sources. Prices include two rechargeable batteries and a charger, automotive power adapter, cable for serial data downloading, waterproof carrying case, operating and safety manual, barcode wand, personal computer software, all necessary hardware accessories and calibration check standards, and a 15-month warranty.

WASTE APPLICABILITY:

The NITON Spectrum Analyzer can detect more than 20 elements in soil samples, such as those obtained from lead-contaminated residences, mining and smelting sites, drum recycling facilities, and plating facilities.

The instrument can provide real-time, on-site analytical results during field screening and remediation operations. FPXRF analysis is faster and more cost effective compared to laboratory analysis.

STATUS:

The NITON Spectrum Analyzer was demonstrated under the SITE Program in April 1995. The results are summarized in Technical Report No. EPA/600/R-97/150, dated March 1998. The instrument was used to identify and quantify concentrations of metals in soils. A preliminary evaluation of the results yielded field-based method detection limits, accuracy, and precision data from the analysis of standard reference materials and performance evaluation samples. Detectors have improved, so detection limits of current instruments are lower than those determined in the 1995 site demonstration. Comparability of the FPXRF results to an EPA-approved reference laboratory method was also assessed. The Draft Fourth Update to SW-846 includes Method 6200, dated January 1998, which is based on this work.

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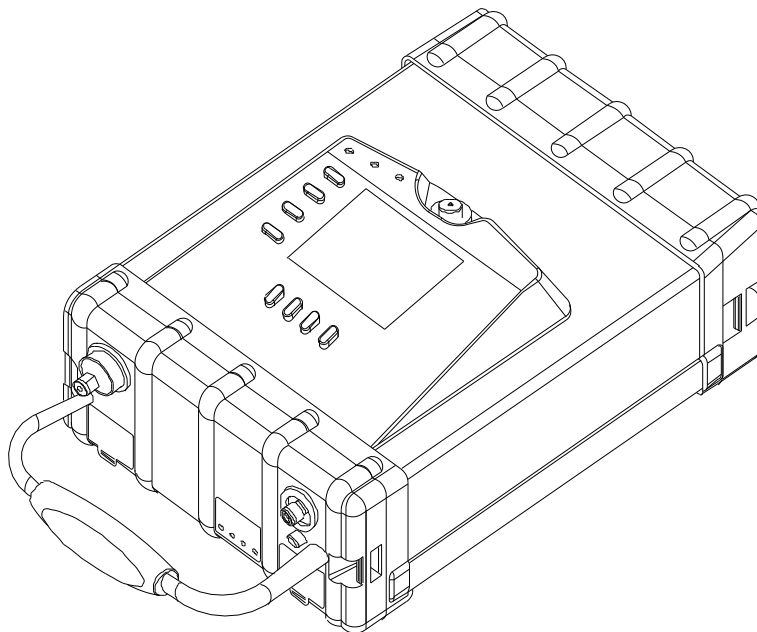
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PE PHOTOVAC INTERNATIONAL, INC.
(formerly PHOTOVAC INTERNATIONAL, INC.)
(PE Photovac Voyager Portable Gas Chromatograph)**TECHNOLOGY DESCRIPTION:**

The PE Photovac Voyager Portable Gas Chromatograph (GC) is a lightweight, battery powered, isothermal GC (see figure below). The Voyager GC is designed to replace the Photovac 10S Plus GC and incorporates the following advanced features:

- A miniature analytical engine containing a precolumn with backflush capability; three analytical columns dedicated for “light”, “middle”, and “heavy” compounds; an isothermal oven with an operating temperature range of 30-80 °C; a miniature all-stainless steel valve array; and a syringe/valve injection port. The whole engine is maintained at the set isothermal temperature.
- The Voyager photoionization detector (PID) provides superior sensitivity to volatile organic compounds (VOC) such as benzene, toluene, xylenes, and chlorinated ethylenes.
- High sensitivity to chlorinated compounds is achieved using a Voyager equipped with an electron capture detector (ECD).
- A VOC function acts as a fast screening tool for pre-GC analysis; the VOC mode supports either syringe or automatic “sample injections.”
- A factory-programmed assay for analysis of up to 40 VOCs listed in EPA Method 601, 602, 624, and 8260.
- A “simplified” operating mode designed to detect a subset of VOCs selected from the preprogrammed assay.
- A user mode, simple point-and-press operation, to analyze preselected compounds from the factory programmed assay.
- Total weight with PID is 15 pounds.



PE-Photovac Portable Gas Chromatograph

WASTE APPLICABILITY:

The Voyager GC can monitor VOC emissions from hazardous waste sites and other emission sources before, during, and after remediation. PC Sitechart LX software provides the user with data downloading, integration and GC customization capabilities. This enables a user to generate data onsite, with confidence.

STATUS:

The Photovac 10S PLUS GC was evaluated in January 1992 at a Superfund site under remediation. Results from this demonstration are presented in a peer-reviewed article entitled "Evaluation of Portable Gas Chromatographs" in the *Proceedings of the 1993 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-33, Volume 2, 1993.

The Voyager GC was evaluated during a field study in August 1995. During the study, downwind vapors from an artificial source generator were analyzed. Preliminary results of the demonstration were presented in an article titled "Performance Comparison of Field-Deployable Gas Chromatographs with Canister TO-14 Analyses" in the *Proceeding of the 1996 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-64, 1996.

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QUADREL SERVICES, INC.
 (Emflux® Soil-Gas Survey System)

TECHNOLOGY DESCRIPTION:

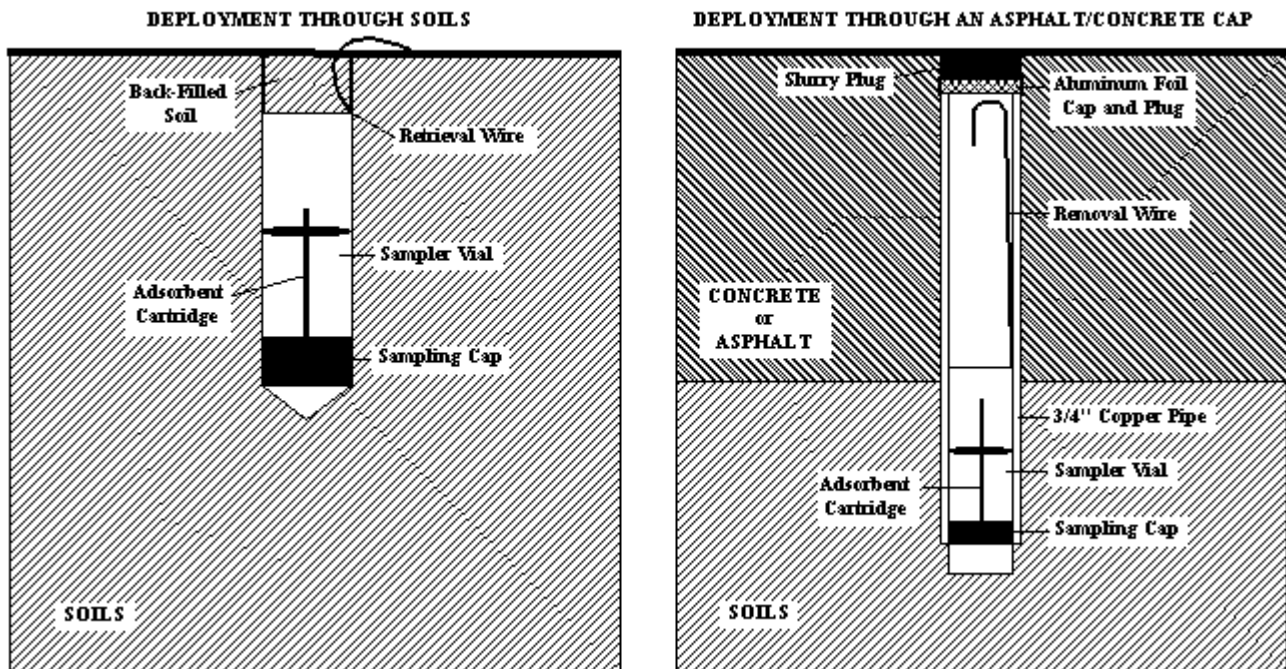
Quadrel's EMFLUX® System is a fully operational, passive, near-surface investigative technology capable of identifying buried VOCs and SVOCs at concentrations in the low parts-per-billion range.

EMFLUX® exploits the crustal effects of gravity (generally referred to as "earth tides") through a predictive computer model. These geophysical forces dominate vertical soil-gas velocities, increasing them by three to five orders of magnitude. The ability to predict such velocity changes (which dwarf influences of barometric pressure, temperature, moisture, and other phenomena) allows EMFLUX® to take advantage of maximum gas emissions at ground surface through simultaneous, cumulative sampling, thereby enhancing

detection accuracy and survey reliability. As a result, EMFLUX® survey results are reproducible in excess of 90 percent of the time in terms of both correct identification of individual VOCs and SVOCs and proportional duplication at ground surface of changes in subsurface concentrations of targeted compounds.

Deployment, by individuals or two-person teams, takes less than two minutes per point (exclusive of initial sample location surveying); retrieval requires half that time; and collectors remain in the field for 72 hours. Field components of the system (9-inch stainless steel shells used above ground, or 3.5-inch glass vials for shallow subsurface placement) are completely portable. Available analytical methods range from EPA Methods 8020 and 8021, using gas chromatography and a variety of detectors, to Methods 8260 and 8270, using mass spectrometry.

EMFLUX ® COLLECTOR



WASTE APPLICABILITY:

The EMFLUX[®] System has been employed with great effectiveness in detecting a broad range of VOCs and SVOCs (from vinyl chloride through hexachlorobutadiene) in soil, groundwater and air. The technology has also been successful in identifying and mapping methane, non-methane landfill gases, mercury, certain types of high explosives, and chemical surety materials.

STATUS:

Quadrel participated in the SITE Program (Environmental Technology Verification Program) in May and June 1997, when EMFLUX[®] was deployed at two sites (one in Colorado, the other in Iowa) to detect, among other VOCs, vinyl chloride, 1,2-DCE, 1,1-DCA, 1,1,1-TCA, TCE and PCE. The demonstration results indicate that the EMFLUX[®] system can provide useful, cost-effective data for environmental problem-solving. The EMFLUX[®] system successfully collected soil gas samples in clay and sandy soils. The sampler provided positive identification of target VOCs and may be able to detect lower concentrations of VOCs in the soil gas than the reference method. The results of the demonstration did not indicate consistent proportional comparability between the EMFLUX[®] data and the reference method's data. Currently, the final report and verification statement is being completed by the National Risk Management Research Laboratory in Las Vegas, Nevada. The EMFLUX[®] system has been commercially operational since 1990. EMFLUX[®] has been used on 350 major projects in 46 U.S. states, in Guam, Canada, Great Britain, South America, Poland, and the Czech Republic.

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RADIOMETER AMERICAN

(Anodic Stripping Voltammetry for Mercury in Soil)

TECHNOLOGY DESCRIPTION:

The Radiometer Analytical Group (Radiometer) anodic stripping voltammetry (ASV) method is a field-portable technique that uses a programmed electrochemical apparatus to measure total mercury in soil and sediment. The Radiometer method is more complex than immunoassay methods, but it can generate quantitative results, while immunoassay methods generate only semiquantitative or screening level results. Each Radiometer ASV apparatus can analyze up to about 40 samples per day for mercury.

Mercury in soil or sediment samples is first extracted using a heated 1:6:17 mixture of hydrochloric acid, nitric acid, and deionized water. The extract is then cooled, buffered, and centrifuged. The extracted samples are then analyzed by ASV using a Radiometer PSU 20 unit.

The ASV method has two steps. In the first step, mercury ions are plated out of solution onto a glassy carbon electrode that is coated with a gold film and placed under a negative potential. In the second step, the negative potential is removed and the mercury is stripped off the electrode. The change in electrode potential is measured with a high impedance voltmeter and is proportional to the mercury concentration.

WASTE APPLICABILITY:

The Radiometer method has been used to analyze soil and sediment samples containing mercury. The effect of soil texture on this method's performance is unknown. Soil moisture content of up to 31 percent had minimal to no effect on performance. The ASV method can measure mercury in soil or sediment at the parts per million (ppm) level.

STATUS:

The Radiometer ASV method was field demonstrated in August 1995 at two southwestern state sites: the Carson River Mercury site in Reno, Nevada; and the Sulphur Bank Mercury Mine site in Clear Lake, California. During the demonstration, the method was used to analyze 145 samples (55 samples from each site and 35 archived samples), 20 field duplicate samples, 17 weak digestion samples, and 13 performance evaluation samples. Duplicate samples underwent confirmatory analysis using inductively coupled plasma with mass spectrometry (ICP-MS) at an off-site laboratory. The ASV method provided reproducible quantitative results comparable to those generated by ICP-MS down to 2 ppm. Additional results from the field demonstration will be available in the Innovative Technology Evaluation Report. According to Radiometer, the PSU 20 unit has been improved to achieve detection limits at the parts per billion level (Radiometer PSU 22 unit).

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