

SCITEC CORPORATION
(Metal Analysis Probe [MAP®] Portable Assayer)

TECHNOLOGY DESCRIPTION:

The SCITEC Corporation MAP® Portable Assayer (see photograph below) is a field portable X-ray fluorescence (FPXRF) analyzer. This FPXRF analyzer can simultaneously analyze for select metals. It is compact, lightweight, and does not require liquid nitrogen. A rechargeable battery allows the FPXRF analyzer to be used at remote sites where electricity is unavailable.

The MAP® Portable Assayer uses a silicon X-ray detector to provide elemental resolution. The unit demonstrated under the SITE Program used a Cadmium-109 radioisotope as the excitation source.

The MAP® Portable Assayer provides high sample throughput and is reportedly easy to operate. Analytical results obtained by this instrument may be comparable to the results obtained by EPA-approved methods.

The instrument is composed of a control console connected to an ambient scanner with a cable. The basic MAP® system also includes a carry pack, rechargeable batteries, operator's manual, target metal standard, and a shipping case. The control console contains a 256-multichannel analyzer (MCA) with a storage capacity of 325 spectra and analyses. The control console weighs 7 pounds and the ambient scanner weighs about 2.5 pounds.

The MAP® Portable Assayer is capable of analyzing 70 samples in an 8- to 10-hour day based on a 240-second analysis time. The instrument is empirically calibrated by the developer. SCITEC requires a 1-day operator training and radiation safety course prior to obtaining a specific license to operate the instrument. The standard MAP® Portable Assayer package sells for \$15,590.



MAP® Portable Assayer

WASTE APPLICABILITY:

The MAP[®] Portable Assayer can detect select metals in soil and sediment samples and in filter and wipe samples. It can also detect lead in paint. The MAP[®] Portable Assayer reportedly can quantitate metals at concentrations ranging from parts per million to percentage levels.

STATUS:

The MAP[®] Portable Assayer has been used at a number of Superfund sites across the country. It was evaluated in April 1995 as part of a SITE demonstration of FPXRF instruments. 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.

Comparability of the FPXRF results to an EPA-approved reference analytical method was also assessed during the demonstration. An EPA SW-846 method for FPXRF analysis of soils was published in 1996. A comprehensive evaluation of all results was presented in a technical report from EPA in 1997.

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SENTEX SENSING TECHNOLOGY, INC.
(Scentograph Plus II Portable Gas Chromatograph)

TECHNOLOGY DESCRIPTION:

The Scentograph Plus II Portable Gas Chromatograph is designed to monitor volatile organic compound (VOC) emissions from hazardous waste sites and other emission sources. It operates by drawing air through a sorbent bed, followed by rapid thermal desorption into the carrier stream. The instrument operates in either Micro Argon Ionization or Micro Electron Capture modes.

The Scentograph Plus II Portable Gas Chromatograph can operate for several hours on internal batteries and has internal carrier gas and calibration tanks. It can be fitted with capillary columns (up to 105 meters, 0.32 or 0.53 millimeter) or packed columns.

The instrument can be operated isothermally at temperatures ranging from ambient to 179°C. Oven temperatures can be programmed at a desired rate. The 11.7- electron-volt ionization energy allows a detection limit of about 0.1 part per billion. The instrument is controlled by a detachable IBM compatible laptop computer (see photograph below). Purge and Trap Accessories enable on-site, on-line determinations of various VOCs in water.

WASTE APPLICABILITY:

The Scentograph Plus II portable gas chromatograph can monitor VOC emissions from hazardous waste sites and other emission sources. A newly developed situ probe allows in situ purge and trap operation, which eliminates the need for water filtration or pre-treatment prior to analysis. This application is specifically suited for wastewater.



Scentograph Plus II Portable Gas Chromatograph

STATUS:

The Scentograph Plus II portable gas chromatograph was evaluated in January 1992 at a Superfund site under remediation. Results from this demonstration are presented in a peer-reviewed article titled "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 technology was also evaluated in June 1994 at a landfill adjacent to a residential area. Results from this demonstration are presented in a peer-reviewed article titled "On-Site Monitoring of Vinyl Chloride at Parts Per Trillion Levels in Air" in the *Proceedings of the 1995 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-47, Volume 1, 1995.

The Scentograph Plus II portable gas chromatograph was also 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. The Scentograph Plus II was also evaluated under an ETV program report published in November of 1998 titled "Environmental Technology Verification Report: Portable Gas Chromatograph, Sentex Systems, Inc. Scentograph Plus II." This document can be obtained from the EPA, technical report number EPA/600/R-98/145.

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SIMULPROBE® TECHNOLOGIES, INC. (Core Barrel Soil Sampler)

TECHNOLOGY DESCRIPTION:

The SimulProbe® Technologies, Inc. (SimulProbe®), core barrel sampler consists of a split core barrel similar to a split-spoon sampler, a drive shoe, and a core barrel head.

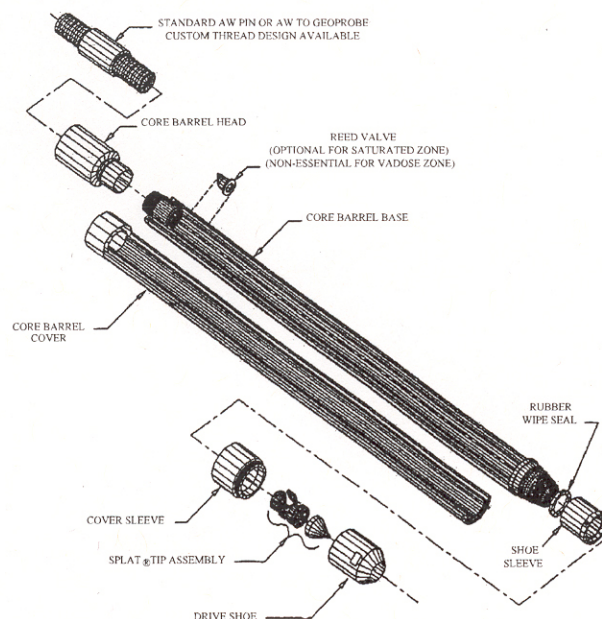
The sampler is constructed of steel, has a uniform 2-inch outer diameter, and is 27 inches long. It is capable of recovering a discrete sample 1.25 inches in diameter and 27 inches long. Multiple 5.25-inch-long stainless-steel liners or a single full-length plastic liner can be used inside the sampler to contain the soil core. The drive shoe of the sampler is equipped with a slide mechanism and has an optional drive tip for direct-push, discrete sampling applications.

The drive tip, known as the SimulProbe® Latch Activated Tip (SPLAT™), seals the sample chamber until the target depth is reached. The SPLAT™ is then released at the target depth to collect the sample.

The core barrel sampler decreases the likelihood of cross-contamination, preserves sample integrity when used with a liner, can collect either discrete or continuous soil samples of unconsolidated materials, does not need specialized training to use, and does not generate drill cuttings.

WASTE APPLICABILITY:

The SimulProbe® core barrel sampler can be used to collect unconsolidated, subsurface soil samples at depths that depend on the capability of the advancement platform. The sampler can be advanced into the subsurface using a direct-push platform, drill rig, or manual methods. The sampler has been used to collect samples of sandy and clayey soil contaminated with high concentrations of volatile organic compounds (VOC). It can also be used to collect samples for semivolatile organic compounds, metals, general minerals, and pesticides analyses.



STATUS:

The SimulProbe® core barrel sampler was demonstrated under the Superfund Innovative Technology Evaluation (SITE) program in May and June 1997 at two sites: the Small Business Administration (SBA) site in Albert City, Iowa, and the Chemical Sales Company (CSC) site in Denver, Colorado. Samples collected during the demonstrations were analyzed for VOCs to evaluate the performance of the samplers.

Demonstration results indicate that the core barrel sampler had higher sample recoveries and yielded samples with higher VOC concentrations in the clayey soil present at the SBA site than the standard methods. Conversely, the sampler had lower recoveries and yielded samples with lower VOC concentrations than the standard methods in the sandy soil present at the CSC site. Sample integrity using the core barrel sampler was not preserved in highly contaminated soil, and the use of sample liners was found to be required to preserve sample integrity. The core barrel sampler's reliability and throughput were not as good as those of the standard methods; however, the developer claims that the sampler used during the demonstrations was incorrectly manufactured. Costs for the core barrel sampler were lower than costs related to the standard sampling method.

Demonstration results are documented in the "Environmental Technology Verification" report for the sampler dated August 1998 (EPA/600/R-98/094).

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SITE-LAB CORPORATION
(Ultraviolet Fluorescence Spectrometer)

TECHNOLOGY DESCRIPTION:

The UVF-3100A includes a portable fluorometer fitted with excitation and emission filters that are appropriate for TPH analysis of soil samples. The fluorometer uses a mercury vapor lamp as its light source. Light from the lamp is directed through an excitation filter before it irradiates a sample extract held in a quartz cuvette. The UVF-3100A can separately measure gasoline range organic (GRO) and extended diesel range organic (EDRO) components of sample extracts. Depending on the analysis being conducted (for example DRO analysis), the fluorometer is fitted with an appropriate emission filter that corresponds to the wavelength at which the sample extract is expected to fluoresce. For GRO, an emission filter with a bandwidth of between 275 and 285 nanometers is used, and for EDRO, an emission filter with a bandwidth of between 300 and 400 nanometers is used.

WASTE APPLICABILITY:

Sitelab's portable ultraviolet fluorescence (UVF) technology specifically measures aromatic contaminants, including TPH fuel oils, PAHs, BTEXs and PCBs. Sitelab also tests aromatic fractions found in Volatile Petroleum Hydrocarbons (VPH), Gasoline Range Organics (GRO), Extractable Petroleum Hydrocarbons (EPH) and Diesel Range Organics (DRO), required by many federal and state regulatory agencies for assessing and cleaning up petroleum sites.



STATUS:

In June 2000, the EPA conducted a field demonstration of the UVF-3100A and six other field measurement devices for TPH in soil. The performance and cost of the UVF-3100A 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-siteLAB® Corporation Analytical Test Kit UVF-3100A" (EPA/600/R-01/080).

DEMONSTRATION RESULTS:

The method detection limit for the UVF-3100A was determined to be 3.4 mg/kg. Eighty-seven of 108 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, 69 were biased low, 33 were biased high. For soil environmental samples, the results were statistically the same as the reference method for one of the five sampling areas. The UVF-3100A exhibited similar overall precision to the reference method (RSD ranges were 3 to 16 percent and 5.5 to 18 percent for the UVF-3100A and the reference method, respectively). The UVF-3100A showed a mean response of less than 5 percent for interferents such as MTBE, PCE, Stoddard solvent, turpentine, 1, 2, 4-trichlorobenzene, and soil spiked with humic acid. The UVF-3100A showed a statistically significant increase in TPH results (15 percent) when the moisture content was increased. Both the measurement time and cost compared well with those of the reference method.

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**SPACE AND NAVAL WARFARE SYSTEMS CENTER
(SCAPS Cone Penetrometer)****TECHNOLOGY DESCRIPTION:**

The Site Characterization and Analysis Penetrometer System (SCAPS) was developed by the space and naval warfare systems center. SCAPS is mounted on a cone penetrometer testing (CPT) platform for field use; it can be fitted with a laser-induced fluorescence (LIF) sensor to provide in situ field screening of petroleum hydrocarbons in subsurface soils. CPT technology has been widely used in the geotechnical industry for determining soil strength and soil type from measurements of tip resistance and sleeve friction on an instrumented probe. The SCAPS CPT platform equipped with LIF sensors can provide real-time field screening of the physical characteristics of soil and chemical characteristics of petroleum hydrocarbon contamination at hazardous waste sites.

SCAPS is primarily designed to quickly and cost-effectively distinguish hydrocarbon-contaminated areas from uncontaminated areas. SCAPS also provides geologic information and reduces the amount of investigation-derived waste. This capability allows further investigation and remediation decisions to be made more efficiently and reduces the number of samples that must be submitted for laboratory analysis.

The LIF system uses a pulsed laser coupled with an optical detector to measure fluorescence through optical fibers. Fluorescence is measured through a sapphire window on a probe that is pushed into the ground with a truck-mounted CPT. LIF provides data on the in situ distribution of petroleum hydrocarbons, measured by the fluorescence response induced in the polynuclear aromatic hydrocarbons (PAH) that comprise the petroleum hydrocarbon. LIF detects PAHs in the bulk soil matrix throughout the vadose, capillary fringe, and saturated zones. LIF also provides a detect-nondetect field screening capability relative to a specified detection limit derived for a specific fuel product on a site-specific soil matrix. In addition, LIF provides qualitative data derived from spectrographic data at depths up to 150 feet.

WASTE APPLICABILITY:

SCAPS CPT technology equipped with LIF sensors can provide real-time qualitative analysis of subsurface soils. This technology may be useful in screening soils at oil refineries, tank farms, and shipyards. The combined technologies provide substantial cost savings and quicker analyses compared to conventional laboratories.

STATUS:

The SCAPS CPT and LIF technologies were demonstrated at two hydrogeologically distinct field sites under the SITE Characterization and Monitoring Program. The demonstrations were conducted at the Hydrocarbon National Test Site at the Naval Construction Battalion Center in Port Hueneme, California in May 1995, and the Steam Plant Tank Farm, Sandia National Laboratories in Albuquerque, New Mexico in November 1995. An Innovative Technology Evaluation Report (ITER) (EPA/540/R-95/520) was published by EPA.

The SCAPS project is meeting the Navy's goals of (1) expedited development and regulatory acceptance, (2) performance of urgently needed petroleum, oil, and lubricant (POL) field screening at Navy facilities, and (3) technology transfer to industry for widespread use. The SCAPS LIF technology is certified and verified. The technology has matured to become a platform with state-of-the-art sensor technology and a suite of the latest CPT tools for sampling and direct push well installations. On August 5, 1996, the California EPA Department of Toxic Substance Control certified the SCAPS LIF as a site characterization technology for real-time, in situ subsurface field screening for POL contaminants, pursuant to California Health and Safety Code, Section 25200.1.5.

Three SCAPS units are performing POL field screenings at Navy facilities on a prioritized basis. These screenings include plume chasing and plume edge delineation on a finer scale than has been feasible in the past.

DEMONSTRATION RESULTS:

The results of the SCAPS demonstrations at Port Hueneme and Sandia National Laboratories were presented in the ITER and are summarized below:

- SCAPS met the demonstration objective of providing real-time screening of the physical characteristics of soil and chemical characteristics of petroleum hydrocarbon contamination.
- SCAPS achieved better than 90 percent agreement with the discrete soil samples and analytical results.
- SCAPS is capable of mapping the relative magnitude and the vertical and horizontal extent of subsurface fluorescent petroleum hydrocarbon contaminant plumes in soil and groundwater.

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SRI INSTRUMENTS
(Compact Gas Chromatograph)**TECHNOLOGY DESCRIPTION:**

The SRI Instruments (SRI) line of compact single- and dual-oven portable gas chromatographs (GC) are designed for on-site and laboratory analysis of organic compounds in soil, water, air, and other matrices. SRI GCs are equipped with ambient-to-400°C programmable column ovens and electronic pressure/pneumatic control (EPC) of all system gases. These GCs include built-in, serially interfaced (RS-232) data acquisition unit that permits use of desktop, notebook, and palmtop PCs and software versions for Windows 3.11/Windows NT 4.00, and Windows '95/'98 (Y2K compliant). SRI GCs are equipped with a standard on-column injection port that accepts packed and capillary columns, and systems may be equipped with multiple injectors and detectors for series or independent operation, as required by the application. Automated gas sampling, split/splitless injection, Method 5035/5030 compliant purge-and-trap concentration, and liquid autosampling carousels are available as options. SRI also manufactures external detector units that may be connected to other host GCs by means of a heated transfer line (provided), or used in stand-alone monitoring applications such as continuous monitoring of stack THC emissions and chlorinated compounds.

WASTE APPLICABILITY:

The SRI GCs can monitor airborne emissions from hazardous waste sites and other emission sources before, during, and after remediation. They can also analyze soil, water, and gas samples for organic contaminants such as benzene, toluene, ethylbenzene, xylene, polychlorinated biphenyls, and pesticides. Their performance characteristics in the field have been proven by a large private, commercial, and government user base.

STATUS:

The SRI model 8610 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.



Compact Gas Chromatograph

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STRATEGIC DIAGNOSTICS, INC.
(formerly ENSYS ENVIRONMENTAL PRODUCTS, INC.)
(EnSys Penta Test System)

TECHNOLOGY DESCRIPTION:

The EnSys Penta Test System is designed to quickly provide semiquantitative results for pentachlorophenol (PCP) in soil samples. The system is shown in the photograph below. The technology uses immunoassay chemistry to produce compound-specific reactions that detect and quantify PCP. Polyclonal antibodies are fixed to the inside wall of a test tube, where they offer binding sites for PCP. An enzyme conjugate containing a PCP derivative is added to the test tube to compete with sample PCP for antibody binding sites. Excess sample and enzyme conjugate are washed from the test tube. Reagents are then added to the test tube to react with the enzyme conjugate, forming a color. After a designated time period, a solution is added to the test tube to stop color formation. The sample color is compared to the color formed by a PCP standard. A differential photometer compares the colors. The results obtained from soil samples are compared against a standard to determine the detection levels.

The system can be affected by extremes of naturally occurring matrix effects such as humic acids, pH, or salinity. Site-specific matrix effects that can affect the system include PCP carriers such as petroleum hydrocarbons or solvents; and other chemicals used in conjunction with PCP, including creosote, copper-chromium-arsenate, or herbicides. Specific chemicals similar in structure to PCP can provide positive results, or cross reactivity.

WASTE APPLICABILITY:

The PCP immunoassay measures PCP concentrations in soil. For semiquantitative soil analysis, the concentration ranges are as follows: greater than 50 parts per million (ppm), between 50 and 5 ppm, between 5 and 0.5 ppm, and less than 0.5 ppm. These ranges can be customized to a user's needs.



EnSys Penta Test System

STATUS:

The SITE demonstration occurred in summer 1993 at Morrisville, North Carolina. Samples collected from Winona, Missouri were transported to the demonstration location for testing. Samples from both sites were analyzed to evaluate the effects of different sample matrices and of different PCP carriers such as diesel fuel and isopropyl ether-butane. During the demonstration, the PENTA RISC Test System analyzed 112 soil samples and 16 water samples. The Innovative Technology Evaluation Report (EPA/540/R-95/514), which details results from the demonstration, is available from EPA.

The PENTA RISC Test System has been accepted under Solid Waste Method 4010 (SW-846, third edition, second update). In the 4 years that it has been available, more than 12,000 immunoassay-based tests have been used on wood preserving sites.

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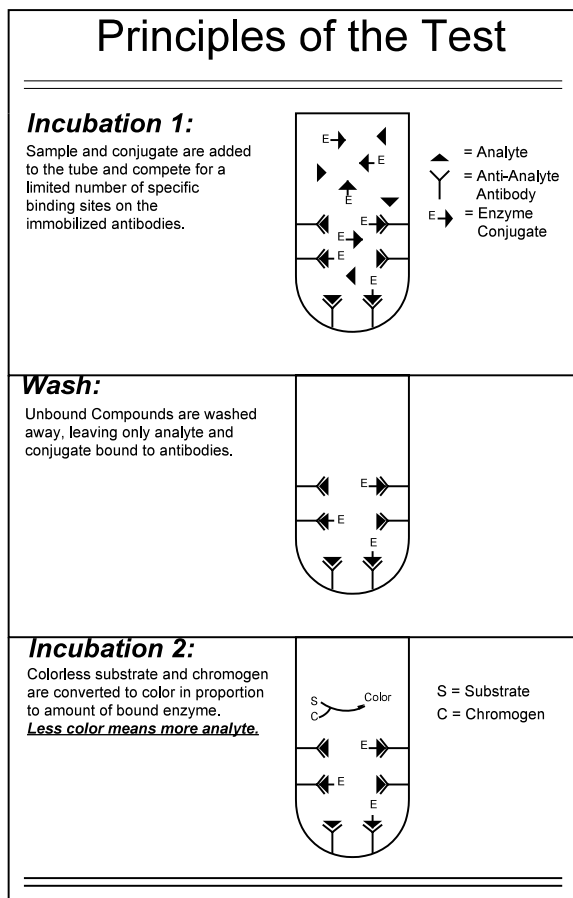
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STRATEGIC DIAGNOSTICS INC.
(EnviroGard™ PCB Immunoassay Test Kit)

TECHNOLOGY DESCRIPTION:

The EnviroGard™ polychlorinated biphenyl (PCB) immunoassay test kit rapidly analyzes for PCB concentrations in samples of soil or sediment. Soil sample extracts are prepared using the EnviroGard™ Soil Extraction Kit and methanol. These extracts and assay calibration solutions are added to plastic test tubes coated with antibodies. Thereafter, PCB-enzyme conjugate is added to each test tube. The test tubes then stand for 15 minutes. The antibodies in each test tube bind with either PCB molecules or enzyme conjugate. Next, the tubes are washed to remove any material not bound to the antibodies. A clear substrate/chromogen solution is then added to each tube, and the tubes are allowed to stand for 5

minutes. Any enzyme conjugate bound to the tubes colors the clear substrate blue. A deeper shade of blue in the test tube indicates a lower PCB concentration. The color intensity in the test tubes is measured at 450 nanometers using a small portable photometer. The color intensity is compared to one or more of the four calibrator solutions included in the kit to yield data allowing classification above or below 1, 5, 10, or 50 parts per million (ppm). Using this technology up to 18 sample extracts can be analyzed in less than 30 minutes. Millipore Corporation (Millipore) can provide optional protocols for quantitative analysis of specific Aroclors or for testing sediment, water, or soil samples.



Test Kit Procedure

WASTE APPLICABILITY:

The EnviroGard™ PCB test kit measures PCB concentrations in soil or sediment. The test is calibrated to screen for Aroclors 1016, 1232, 1242, 1248, 1254, and 1260 at greater than 95 percent confidence interval.

In 1991, the EnviroGard™ PCB test kit was used to screen and quantify PCB contamination in soils at a SITE demonstration of a solvent extraction system in Washburn, Maine.

Soil containing over 50 ppm PCB was required for the demonstration at the Washburn, Maine site. Calibrators at the 5 and 50 ppm level were used to evaluate the test kit's potential for segregating soils. Additional tests were performed on dilutions of the soil extracts to evaluate quantitative performance. Highly contaminated soils were easily identified, and quantitative tests provided correlation to contaminant levels obtained by off-site laboratory analysis using EPA Method 8080. The Innovative Technology Evaluation Report (EPA/540/R-95/517) for this study is available from the EPA.

The kit was also demonstrated at a U.S. Department of Energy (DOE) site in Kansas City, Missouri. Soils contaminated with Aroclor 1242 in ranges from nondetectable to greater than 1,000 ppm were analyzed with the test kit at the DOE facility. Over 200 assays of environmental samples and calibrators were performed to evaluate correlation with both on-site and off-site laboratory gas chromatograph data. Final evaluation of the data will be presented in the Technology Evaluation Report.

The EnviroGard™ PCB test kit has been accepted by the EPA Office of Solid Waste for inclusion in SW-846 as Method 4020.

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STRATEGIC DIAGNOSTICS, INC.
(Immunoassay and Colorimetry)**TECHNOLOGY DESCRIPTION:**

The EnSys Petro Test System manufactured by SDI is based on a combination of immunoassay (specifically, enzyme-linked immunosorbent assay) and colorimetry. The EnSys Petro Test System includes the SDA Sample Extraction Kit, the EnSys Petro 12T Soil Test Kit, and the EnSys/EnviroGard® Common Accessory Kit. With this device, methanol is used for extraction of petroleum hydrocarbons from soil samples. Each sample extract is mixed with an enzyme conjugate solution. The reaction mixture is then transferred to an antibody-coated test tube. The hydrocarbons in the soil extract and those in the enzyme conjugate competitively bind to specific antibody sites on the test tube. The test tube is rinsed with a dilute detergent solution to remove any enzyme conjugate and hydrocarbons not bound to the antibodies. A color developer solution and hydrogen peroxide are added to the test tube in order to give yellow color to the enzymes that remain attached to the test tube. The color intensity is inversely proportional to the concentration of hydrocarbons in the extract. To accomplish color measurement, the absorbance of the antibody-coated tube containing the sample extract and an antibody-coated tube containing a reference standard (m-xylene) is compared using a differential photometer. A positive reading on the photometer indicates that the total concentration of petroleum hydrocarbons in the sample extract is less than that in the reference standard. Similarly, a negative reading on the photometer indicates that the total concentration of petroleum hydrocarbons in the sample extract is greater than that in the reference standard.

WASTE APPLICABILITY:

The EnSys Petro Test System qualitatively measures the concentration of petroleum hydrocarbons in environmental soil samples.

STATUS:

In June 2000, the EPA conducted a field demonstration of the EnSys Petro Test System and six other field measurement devices for TPH in soil. The performance and cost of the EnSys Petro Test System 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-Strategic Diagnostics, Inc., EnSys Petro Test System" (EPA/600/R-01/084).

DEMONSTRATION RESULTS:

During the demonstration, the EnSys Petro Test System exhibited the following desirable characteristics of a field TPH measurement device: (1) good precision and (2) high sample throughput. In addition, the EnSys Petro Test System exhibited moderate measurement costs. However, a significant number of the EnSys Petro Test System TPH results were determined to be inconclusive because the detection levels used by SDI were not appropriate to address the demonstration objectives. Overall, the device's results did not compare well with those of the reference method; in general, the device exhibited a high positive bias. Collectively, the demonstration findings indicated that the user should exercise caution when considering the device for site-specific field TPH measurement application.

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




TECHNOLOGY DESCRIPTION:

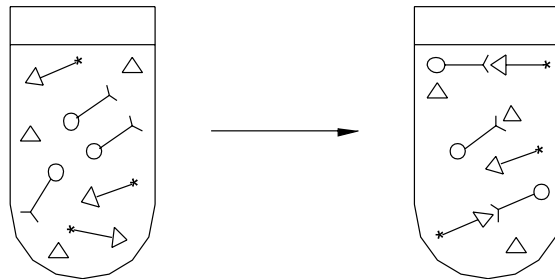
The RaPID Assay® kit is designed to quickly provide quantitative results for pentachlorophenol (PCP) concentrations in soil and water samples. The kit uses immunoassay chemistry to produce detectable and quantifiable compound-specific reactions for PCP, as shown in the figure below. Polyclonal antibodies bound to paramagnetic particles are introduced into a test tube where they offer binding sites for PCP. An enzyme conjugate containing a PCP derivative is added to the test tube, where it competes with PCP from samples for antibody binding sites. A magnetic field is applied to each test tube to hold the paramagnetic particles containing PCP and enzyme conjugate, while excess sample and enzyme conjugate are washed from the test tube.

Reagents are then added to the test tube, where they react with the enzyme conjugate and form a color. The color formed in the sample is compared to the color formed by PCP calibration standards. The comparison is made with a spectrophotometer. Samples with PCP concentrations above the calibration range can be diluted and reanalyzed.

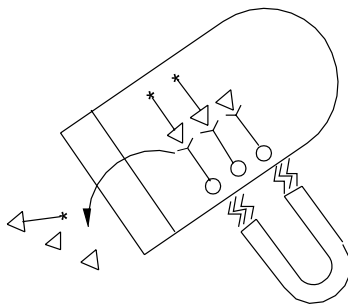
The RaPID Assay® kit has several advantages and limitations when used under field conditions. The method is field portable, easy and fast to operate, and inexpensive. The RaPID Assay® kit is limited in that (1) electricity is required to operate the spectrophotometer, (2) the immunoassay method may be affected by temperature fluctuations, and (3) cross-reactivity may occur for compounds similar to PCP.

Legend

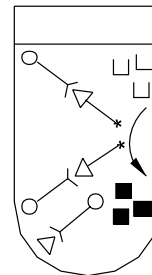
-  Magnetic Particle with Antibody Attached
-  Pentachlorophenol Enzyme Conjugate
-  Pentachlorophenol
-  Chromogen/Substrate
-  Colored Product



1. Immunological Reaction



2. Separation



3. Color Development

RaPID Assay®

WASTE APPLICABILITY:

The RaPID Assay[®] kit can be used to identify and quantify PCP in soil and water samples. The developer reports the detection limit for soils at 0.1 part per million and water samples at 0.06 part per billion.

STATUS:

The RaPID Assay[®] kit was evaluated during a SITE field demonstration in Morrisville, North Carolina in August 1993. A photograph of the kit is shown below. In addition, samples collected from a location in Winona, Missouri were analyzed to evaluate the effects of different matrices and PCP carriers. The Innovative Technology Evaluation Report (EPA/540/R-95/514), which details results from the demonstration, is available from EPA.

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RaPID Assay Used During the SITE Demonstration

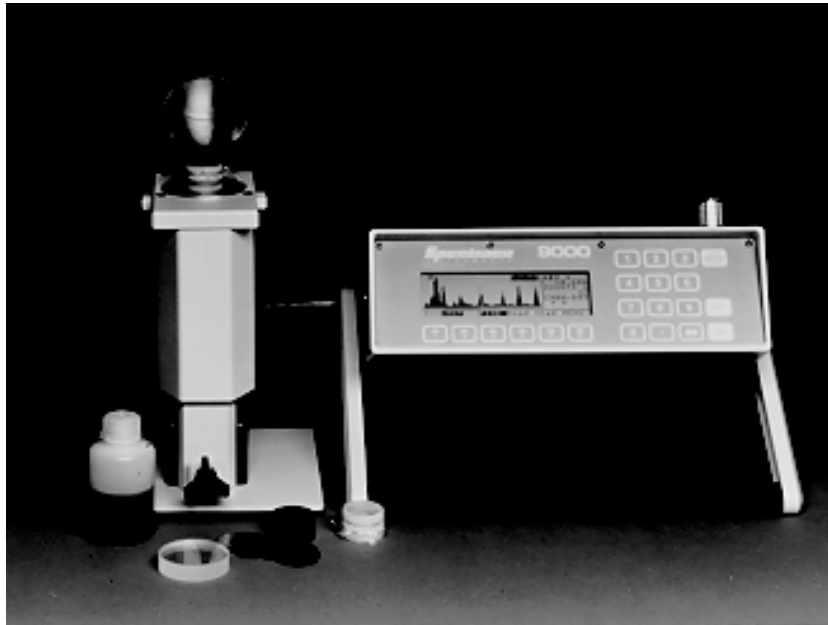
**THERMO NORAN
(formerly TN Spectrace)
(TN 9000 and TN Pb X-Ray Fluorescence Analyzers)**

TECHNOLOGY DESCRIPTION:

The TN 9000 X-ray Fluorescence (XRF) Analyzer (see photograph below) is a field portable unit that simultaneously analyzes elements ranging from sulfur to uranium. The TN Pb Analyzer was designed to analyze for lead in soil, paint and paint chips, and other matrices. It can also measure arsenic, chromium, iron, copper, manganese, and zinc in soils. Both instruments are compact, lightweight, and do not require liquid nitrogen. A rechargeable battery allows the XRF analyzers to be used at remote sites where electricity is unavailable.

The TN 9000 Analyzer and the TN Pb Analyzer both use a high-resolution mercuric iodide detector to provide elemental resolution and low detection limits. The TN 9000 Analyzer is equipped with the radioisotope sources iron-55, cadmium-109, and americium-241, which allow for identification and quantification of 26 elements. The TN Pb Analyzer is equipped only with the cadmium-109 source, which allows for the quantification and identification of the seven elements listed above.

The TN 9000 Analyzer and TN Pb Analyzer consist of two main components: a probe and an electronics unit. The probe is connected to the electronics unit by a flexible cable that allows analysis of soil samples in the in situ or intrusive modes. The probe contains the detector and excitation sources and weighs approximately 4 pounds. The electronics unit contains a 2,048-multichannel analyzer for spectral analysis. A maximum of 300 sets of results and 120 spectra can be stored in the TN 9000 before downloading to a personal computer (PC). A maximum of 600 sets of results and 100 spectra can be stored in the TN Pb Analyzer before downloading to a PC. All elemental concentrations are displayed in parts per million on the liquid crystal display (LCD) of the electronic console. The electronics unit weighs approximately 15 pounds and can be carried in the field in a water-repellant carrying case. The electronic unit is battery-powered and can run up to 8 hours on a full charge.



TN 9000 X-Ray Fluorescence Analyzer

Both instruments incorporate user-friendly, menu-driven software to operate the instrument. The TN 9000 Analyzer and TN Pb Analyzer are calibrated using fundamental parameters, which is a standardless calibration technique. At the time of the SITE demonstration, the TN 9000 and TN Pb Analyzers cost \$58,000 and \$39,500, respectively. These costs included all equipment necessary to operate the instrument. Leasing and rental options are also available. The TN 9000 Analyzer, using all three excitation sources, is capable of analyzing 100 samples per day. The TN Pb Analyzer is capable of analyzing 20 to 25 samples per hour using a 60-second count time for the cadmium-109 source.

WASTE APPLICABILITY:

The TN 9000 and TN Pb Analyzers can detect select elements in soil, sediment, filter, and wipe samples. The TN Pb Analyzer can also detect lead in paint. Both units can identify select elements at concentrations ranging from parts per million to percentage levels in soil samples obtained from mining and smelting sites, drum recycling facilities, and plating facilities. These instruments can provide real-time, on-site analytical results during field screening and remediation operations. XRF analysis is faster and more cost-effective compared to conventional laboratory analysis.

STATUS:

The TN 9000 and TN Pb Analyzers were demonstrated under the SITE Program in April 1995. The results were summarized in Technical Report No. EPA/600/R-97/145, 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 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 is based on this demonstration. TN Pb - no longer offered.

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TRI-SERVICES (Site Characterization and Analysis Penetrometer System [SCAPS])

TECHNOLOGY DESCRIPTION:

The Tri-Services Site Characterization and Analysis Penetrometer System (SCAPS) was developed by the U.S. Army (U.S. Army Corps of Engineers, Waterways Experiment Station [WES] and the Army Environmental Center [AEC]), Navy (Naval Command, Control and Ocean Surveillance Center), and the Air Force (Armstrong Laboratory). The U.S. Army holds a patent for the application of laser sensors combined with cone penetrometry. The laser-induced fluorescence (LIF) system used in the SCAPS was modified from a design developed by the Navy to detect petroleum, oil, and lubricant fluorescence in seawater.

A complete cone penetrometer (CPT) truck system consists of a truck, hydraulic rams and associated controllers, and the CPT itself (see photograph below). The weight of the truck provides a static reaction force, typically 20 tons, to advance the CPT. The hydraulic system, working against the static reaction force, advances 1-meter-long, 3.57-centimeter-diameter threaded push rod segments into the ground. The CPT, which is mounted on the end of the series of push rods, contains LIF sensors that continuously log tip stress and sleeve friction.

The data from these sensors are used to map subsurface stratigraphy. Conductivity or pore pressure sensors can be driven into the ground simultaneously. The 20-ton truck is designed with protected work spaces.

The SCAPS has been modified to provide automatic grouting of the penetrometer hole during retraction of the CPT. It can also decontaminate the push rods as they are retracted from the soil. The 20-ton CPT system is capable of pushing standard push rods to depths of approximately 50 meters.

The main LIF sensor components are as follows:

- Nitrogen (N₂) laser
- Fiber optic cable
- Monochromator to resolve the fluorescence emission as a function of wavelength
- Photodiode array (PDA) to detect the fluorescence emission spectrum and transduce the optical signal into an electrical signal
- optical multichannel analyzer (OMA) to interface between the optic system and the computer system
- Computer system



Site Characterization and Analysis Penetrometer System (SCAPS)

To operate the SCAPS LIF sensor, the CPT is positioned over a designated penetration point. The LIF sensor response is checked using a standard rhodamine solution held against the sapphire window; sensor response is checked before and after each penetration. The CPT is then advanced into the soil.

The SCAPS LIF system is operated with a N₂ laser. The PDA accumulates the fluorescence emission response over 10 laser shots, and the PDA retrieves an emission spectrum of the soil fluorescence and returns this information to the OMA and computer system. The LIF sensor and stratigraphy data collection are interpreted by the on-board computer system.

The spectral resolution of the LIF system under these operating conditions is 2 centimeters. The fluorescence intensity at peak emission wavelength for each stored spectrum is displayed along with the soil classification data.

WASTE APPLICABILITY:

The Tri-Services SCAPS was designed to qualitatively and quantitatively identify classes of petroleum, polynuclear aromatic hydrocarbon, and volatile organic compound contamination in subsurface soil samples.

STATUS:

The technology field demonstration was held in EPA Region 7 during September 1994. The Innovative Technology Evaluation Report (EPA/540/R-95/520) is available from EPA. Since the SITE demonstration in 1994, the U.S. Army has developed the SCAPS Petroleum

Sensor (for detection of fluorescing petroleum, oil and lubricant contaminants in groundwater and soil), SCAPS Explosives Sensor (for detection of nitrogen-based explosive compounds), SCAPS Hybrid VOC Sensor/Sampler (for detection of VOCs in soil), SCAPS Metals Sensor (for in situ detection of metal contaminants in subsurface media), and a SCAPS Radionuclide Sensor (for detection of gamma emitting radionuclides in groundwater, mixed tank wastes, and soil). These technologies have not been demonstrated in the SITE Program.

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**UNITED STATES ENVIRONMENTAL
PROTECTION AGENCY**
(Field Analytical Screening Program - PCB Method)**TECHNOLOGY DESCRIPTION:**

The field analytical screening program (FASP) polychlorinated biphenyl (PCB) method uses a temperature-programmable gas chromatograph (GC) equipped with an electron-capture detector (ECD) to identify and quantify PCBs in soil and water. Gas chromatography is an EPA-approved method for determining PCB concentrations. The FASP PCB method is a modified version of EPA SW-846 Method 8080.

In the FASP PCB method for soil samples, PCBs are extracted from the samples, injected into a GC, and identified and quantified with an ECD. Soil samples must be extracted before analysis begins. Hexane and sulfuric acid are used during the extraction process, which removes potential interferences from the soil sample. Chromatograms for each sample are compared to the chromatograms for PCB standards. Peak patterns and retention times from the chromatograms are used to identify and quantify PCBs in the soil sample extract. In addition to the GC, the operator may use an autosampler that automatically injects equal amounts of the sample extract into the GC column. The autosampler ensures that the correct amount of extract is used for each analysis and allows continual analysis without an operator. The FASP PCB method quickly provides results with statistical accuracy and detection limits comparable to those achieved by formal laboratories. The method can also identify individual Aroclors.

Instrumentation and equipment required for the FASP PCB method are not highly portable. When mounted in a mobile laboratory trailer, however, the method can operate on or near most sites relatively easily. Use of this method requires electricity, and Aroclor standards require refrigeration. An exhaust hood and carrier gases also are needed.

WASTE APPLICABILITY:

The FASP PCB method can identify and quantify PCBs in soil and water samples.

STATUS:

The FASP PCB method was demonstrated under the SITE Program at a well-characterized, PCB-contaminated site. During the demonstration, the method was used to analyze 112 soil samples, 32 field duplicates, and two performance evaluation samples. Split samples were submitted to an off-site laboratory for confirmatory analysis by SW-846 Method 8080. Data generated by the FASP PCB method were directly compared with the data from the off-site laboratory to evaluate the method's accuracy and precision. In addition, the operational characteristics and performance factors of the FASP PCB method were evaluated.

The stated detection limit for the FASB PCB method is 0.4 parts per million (ppm). During the demonstration, the method achieved a detection limit as low as 0.1 ppm. In addition, up to 21 samples were analyzed by the method in an 8-hour period. The Innovative Technology Evaluation Report (EPA/540/R-95/521) contains additional details on the method's demonstration and evaluation and is available from EPA.

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WILKS ENTERPRISE, INC.
(Infrared Analysis)

TECHNOLOGY DESCRIPTION:

The Infracal® TOG/TPH Analyzer developed by Wilks is based on infrared analysis. The device can be operated as either Model CVH or Model HATR-T simply by switching sample stages. Model CVH uses a sample stage that contains a quartz cuvette, and Model HATR-T uses the cubic zirconia horizontal attenuated total reflection sample stage. Model CVH is used when a sample contains GRO, extended diesel range organics (EDRO), or both, and Model HATR-T is used when a sample contains only EDRO. Because of the environmental hazards associated with chlorofluorocarbons, Model HATR-T, which uses Vertrel® MCA, is preferred over Model CVH, which uses Freon 113, a chlorofluorocarbon. However, Model CVH is more sensitive and can achieve a lower detection limit than Model HATR-T.

The Infracal® TOG/TPH Analyzer includes a single-beam, fixed-wavelength, nondispersive infrared filter-based spectrophotometer with a dual detector system. In Model CVH, a pulsed beam of infrared radiation from a tungsten lamp is transmitted to a quartz cuvette that contains a sample extract. In Model HATR-T, which is an evaporation technique, an extract is placed directly on the sample stage. The radiation that passes through the sample extract enters the dual detector system, whose filters isolate a reference wavelength (2,500 nanometers) and an analytical wavelength (3,400 nanometers) to measure PHCs present in the extract.

WASTE APPLICABILITY:

The Infracal® TOG/TPH Analyzer measures total oil and grease or total petroleum hydrocarbon concentration levels in soil or water.



Model HATR-T



MODEL CVH

STATUS:

Two models of the Infracal[®] TOG/TPH Analyzer – the Model HATR-T and CVH – were demonstrated in June 2000 at an EPA SITE Study on Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil. Over 200 soil samples were analyzed. Environmental samples were collected in five areas contaminated with gasoline, diesel, lubricating oil and other petroleum products. Performance evaluation samples were prepared by a commercial provider. The performance attributes tested included method detection limits, accuracy and precision, effect of interferents, skill and training required, portability and durability, and cost and time per sample. The performance and cost were compared to an off-site laboratory reference method, (SW-846) Method 8015 B. The Innovative Technology Verification Report (EPA/600/R-X01/088) is available from the EPA.

DEMONSTRATION RESULTS:

The method detection limit was determined to be 76 mg/kg for the Infracal TOG/TPH Analyzer. Seventy-two of 101 results agreed with those of reference method. There were 2 false positives, and 27 false negatives. Of 105 results used to measure measurement bias, 78 were biased low, and 27 were biased high. For soil environmental samples, the results were statistically the same as the reference method for one out of

five sampling areas. The analyzer exhibited less overall precision than the reference method (RSD ranges were 5 to 30 percent and 5.5 to 18 percent for the device and the reference method respectively. The analyzer showed varying mean responses for interferents such as PCE (1 percent), MTBE (62 percent), Stoddard solvent (120 percent), and turpentine (77 percent). Moisture content had a statistically significant impact on TPH results for diesel soil samples, but not for weathered gasoline soil samples. Both the measurement time and cost compared well with those of the reference method.

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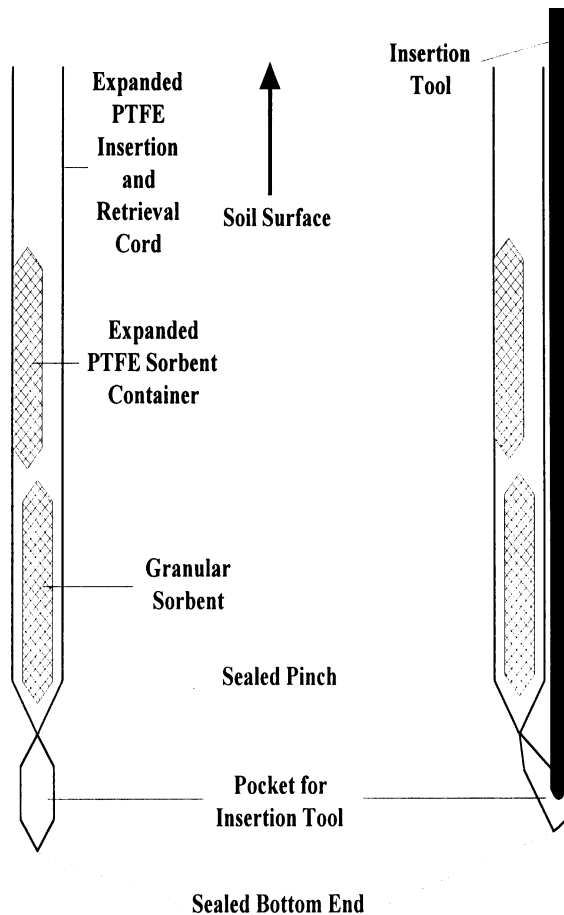
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W.L. GORE AND ASSOCIATES, INC.
(GORE-SORBER® Screening Survey)

TECHNOLOGY DESCRIPTION:

The GORE-SORBER® Screening Survey employs the use of patented passive soil vapor sampling devices (GORE-SORBER Modules), which are made of an inert, hydrophobic, microporous expanded polytetrafluoroethylene (ePTFE, similar to Teflon® brand PTFE) membrane. The membrane transfer of soil and liquid, but allows the soil gases to move across the membrane for collection onto engineered sorbents. These sorbents are designed to minimize the affects of water vapor and to detect a broad range of VOCs and SVOCs.

GORE-SORBER® Screening Surveys have been used successfully at thousands of sites for determining subsurface areas impacted by VOCs and SVOCs. Organic compounds commonly detected include halogenated solvents, straight- and branched-chain aliphatics, aromatics, and polycyclic aromatic hydrocarbons (PAH). Many of these compounds are associated with a wide range of petroleum products, including gasoline, mineral spirits, heating oils, creosotes, and coal tars. GORE-SORBER® Screening Surveys have also been used successfully to screen for nitroaromatic explosives, chemical warfare agents, precursors, breakdown products, and pesticides.



GORE-SORBER®

The GORE-SORBER® Screening Survey is a service that includes the manufacturing of the samplers, the analysis of the samplers (through thermal desorption, gas chromatography, and mass selective detection), and a final report that includes color contour plots of the compounds detected.

WASTE APPLICABILITY:

Common applications of the GORE-SORBER® Screening Surveys include detection of compounds to (1) trace soil and groundwater plumes in porous and fractured media, (2) monitor progress of subsurface in situ remedial actions, (3) provide baseline data for real estate transfer assessments, and (4) reduce groundwater monitoring costs. Prudent use of this technology can optimize and reduce soil and groundwater sampling efforts, resulting in significant cost savings over the life of site assessment and remedial action programs.

The GORE-SORBER® Screening Survey was accepted into the SITE Demonstration Program in November 1996. The SITE field demonstration was completed in May 1997. Since this technology has been accepted into the SITE program, water quality monitoring and the design of the GORE-SORBER Module have been improved.

The SITE demonstration showed that the GORE-SORBER® Screening Survey is more sensitive than active soil gas sampling, and therefore more accurate in terms of detecting and reporting low concentrations of some compounds. The technology demonstration also revealed that this survey is more accurate when the soil conditions would otherwise restrict the use of active soil gas methods, for example, where the soil is very dense or nearly saturated. Additionally, this sorbent based method provides a more robust system for sample collection and analysis for those projects that have more stringent data quality objectives.

Demonstration results are documented in the "Environmental Technology Verification" report for the sampler dated August 1998 (EPA/600/R-98/095).

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XONTECH INCORPORATED
(XonTech Sector Sampler)

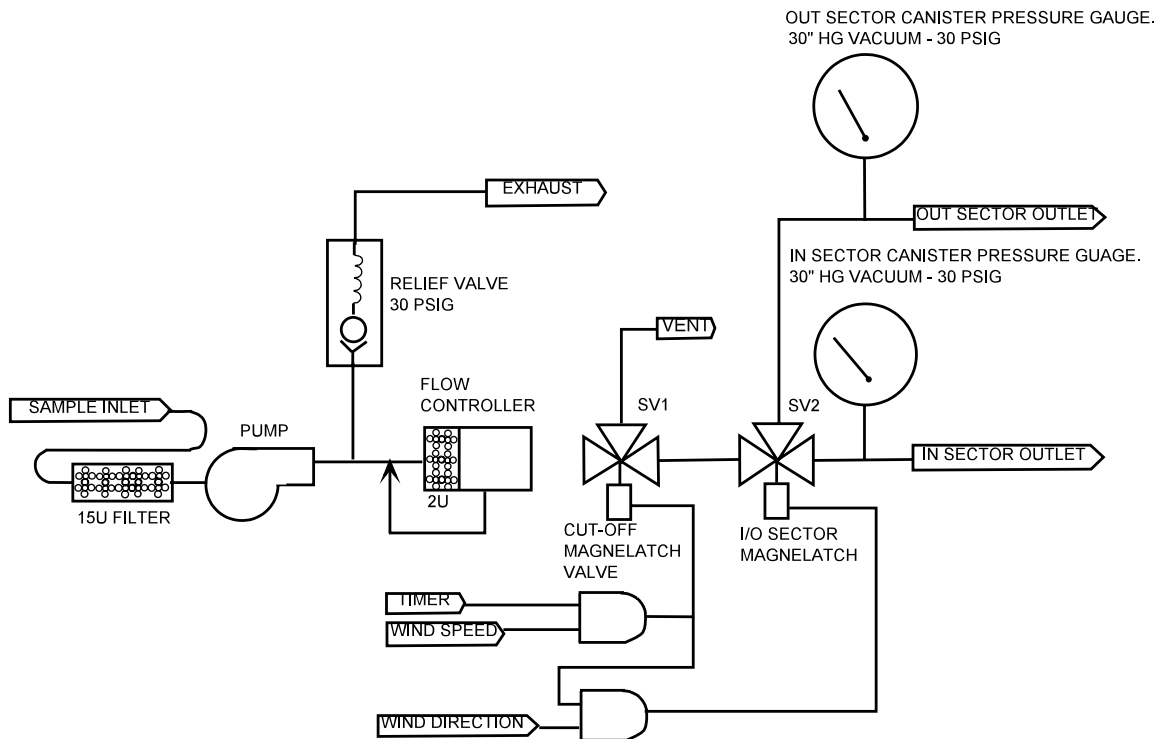
TECHNOLOGY DESCRIPTION:

The XonTech Incorporated (XonTech) sector sampler collects time-integrated whole air samples in Summa™-polished canisters (see diagram below). The wind sensor directs whole air, sampled at a constant rate, into either an "in" sector canister or an "out" sector canister. When wind velocity exceeds 0.37 meter per second (m/s) from the direction of the suspected emissions area (the target), the first canister is filled. When the wind velocity exceeds 0.37 m/s from any other direction, the other canister is filled. When the wind velocity falls below 0.37 m/s, either canister or neither canister may receive the sample. Over an extended period of time, a target sample and a background sample are collected. This method is analogous to upwind-downwind sampling but does not require two distinct sites or manual sampler control.

The sampler is portable and can be battery- or AC-powered. The air samples are analyzed by gas chromatograph (EPA Method TO-14) for volatile organic compounds (VOC). The use of sector samplers enables identification of VOCs originating from the source and differentiation between other sources in the vicinity.

WASTE APPLICABILITY:

The XonTech sector sampler can monitor VOC emissions from hazardous waste sites and other emission sources before and during remediation. Short-term sampling can determine which high concentration compounds are emitted from a site. Long-term monitoring can assess an emission source's potential effects on the local population, providing data to support risk analyses.



Schematic Diagram of the XonTech Sector Sampler

STATUS:

The XonTech sector sampler's usability has been demonstrated in two short-term field studies. This technology has been applied to industrial emissions as well as emissions from landfill sites. Mathematical methods for processing data have been developed and shown to be appropriate.

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