Portable Sensor for Hazardous Waste

Developer: Physical Sciences, Inc.
Contract Number: DE-AC21-93MC30175
Crosscutting Area: CMST

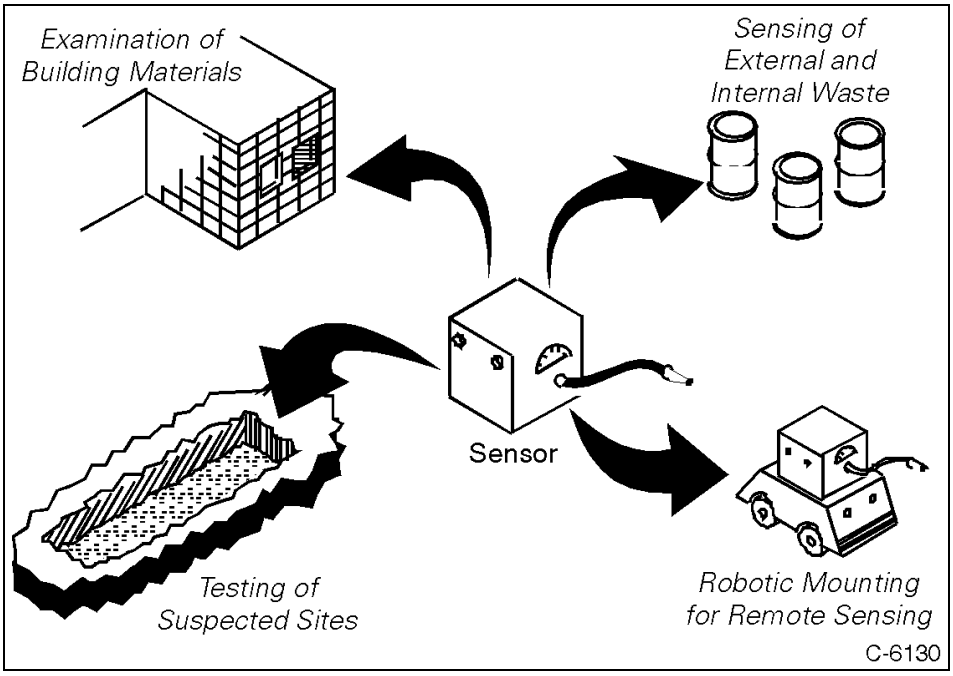
Deactivation & Decommissioning FOCUS AREA

Problem:

Many Department of Energy (DOE) sites have areas, buildings, and waste materials which are contaminated with hazardous chemicals including organics, heavy metals, and radionuclides. Current hazardous waste site characterization and compliance monitoring methods generally involve sample retrieval, packaging, transportation, and off-site analysis. This process is both expensive and time consuming. Better methods are needed to accelerate site characterization, improve compliance assurance, and reduce site cleanup costs. New technologies are needed that are capable of rapid and sensitive detection of hazardous compounds for a variety of applications while maintaining portability for field use.

Solution:

This need could be met with the development and demonstration of a compact, portable, real-time analytical instrument using the Spark-Induced Breakdown Spectroscopy (SIBS) technique to quantify concentrations of specific hazardous components, including RCRA heavy metals, such as mercury (Hg), chromium (Cr), cadmium (Cd), arsenic (As), and lead (Pb), and radionuclides, such as uranium (U), thorium (Th), and technicium (Tc).



Benefits:

- Portable and sensitive detection of hazardous waste contaminants
- Simultaneous, multi-component detection of heavy metals and radionuclides
- Suitable for site characterization, remediation status, compliance assurance, continuous emissions monitoring, and industrial health and safety
- Reduced sampling and analysis costs

Technology:

This project is to develop a sensitive, portable, field-operable instrument to analyze suspected waste materials for the presence and quantity of heavy metals such as mercury, chromium, cadmium, arsenic, and lead, and radioactive species such as uranium, thorium, and technicium.

The fundamental principle of the monitor is SIBS. This system vaporizes particulate samples in a high energy, electrically generated spark. With suitable processing of the fluorescence radiation, background emissions can be suppressed with respect to the atomic fluorescence of the analyte species. This fluorescence is conventionally detected using simple optical detectors. The strong fluorescence signals achieved by SIBS allows for simultaneous, real-time, multi-component detection with high sensitivity (parts per billion).

The spark generator is light weight and requires low power thus enabling a compact and portable monitor to be constructed. The monitor could be moved to test suspect areas and materials for possible contamination, as shown in the figure. Sampling would be continuous and accomplished via an attached extractor probe. The portability and sampling features will reduce human exposure incurred during sample extraction and will allow more thorough inspections.

The unit was designed to be fully self-contained and calibrated. A dedicated processor is used to identify the contaminant from the fluorescence wavelength and utilizes the stored calibrations to produce a concentration level output. An adjustable audio alarm is incorporated to indicate exceedance of toxicity levels. The instrument can be used during initial site evaluation and to gauge decontamination effectiveness and completion.

Project Conclusion:

This project was completed in January 1998 at the end of the second of three planned phases of development. For the second phase of development, Physical Sciences, Inc.'s (PSI's) understanding of DOE site needs indicated that most applications which could benefit from the originally proposed ANET technology required handling particulate samples. This understanding helped redirect the development effort toward Spark-Induced Breakdown Spectroscopy (SIBS), rather than the ANET excitation technique. The SIBS system vaporizes particulate samples in a high energy, electrically generated spark. Sensitive detection of the following species has been demonstrated: Antimony (Sb), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Lead (Pb), Arsenic (As), Mercury (Hg), Uranium (U), Thorium (Th), and Technetium (Tc).

At project completion, PSI had developed a detailed set of drawings and specifications for the construction of a first generation (alpha) prototype instrument, which was to have been assembled and tested in the next development phase. Tests of various sensors for continuous air monitoring of Resource Conservation and Recovery Act (RCRA) metals were conducted by the Mixed Waste Focus Area (MWFA). As a result of this testing, the MWFA did not support continuation of development and FETC decided not to continue this project.

Contacts:

PSI is a small business dedicated to producing new commercial products and entities through research and development. For information on this project, the contractor contact is:

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DOE's Federal Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

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