Real Time Data for Remediation Activities - [11505]

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

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Real Time Data for Remediation Activities - [11505]

C. T. Brock
CH2M HILL Plateau Remediation Company

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ABSTRACT
Health physicists from the CH2M HILL Plateau Remediation Company collaborated with Berkeley Nucleonics Corporation to modify the SAM 940 isotope identifier instrument to be used for nuclear waste remediation. These modifications coupled with existing capabilities of the SAM 940 have proven to be invaluable during remediation activities, reducing disposal costs by allowing swift remediation of targeted areas that have been identified as having isotopes of concern (IOC), and eliminating multiple visits to sites by declaring an excavation site clear of IOCs before demobilizing from the site. These advantages are enabled by accumulating spectral data for specific isotopes that is nearly 100 percent free of false positives, which are filtered out in “real time.”

INTRODUCTION
Health physicists from the CH2M HILL Plateau Remediation Company (CHPRC) Soil & Groundwater Remediation Project (SGRP) collaborated with Berkeley Nucleonics Corporation (BNC), San Rafael, California, to modify the SAM 940 isotope identifier instrument to be used for nuclear waste remediation. The SAM 940 was initially capable of isotope identification with GPS, but required system modification to enable the following additional capabilities:

- Alarm and automatically start an acquisition at a preset value for individual isotopes
- Map gross counts and counts for individual isotopes with GPS coordinates, time and date (this is referred to as data logging with a one-second time resolution)
- Instantaneously display isotopes as they are detected in the environment
- Perform GPS data logging and spectral acquisition simultaneously.

These modifications coupled with existing capabilities of the SAM 940 have proven to be invaluable during remediation activities, reducing disposal costs by allowing swift remediation of targeted areas that have been identified as having isotopes of concern (IOC), and eliminating multiple visits to sites by declaring an excavation site clear of IOCs before demobilizing from the site. These advantages are enabled by accumulating spectral data for specific isotopes that is nearly 100 percent free of false positives, which are filtered out in real time. The data is also contained on a CF memory card in a format lending itself to mapping remediated areas.

The SAM 940 system is used to support remedial activities by pairing its ability to identify IOCs with its sensitive detection capability. Its built-in alarm informs the user of the presence of activity above the set threshold. Then the activity is identified as an IOC needing remediation or potentially naturally occurring radioactive material (NORM) not requiring cleanup. This ability has reduced disposal costs of the project by better targeting remediation areas.
BACKGROUND

The CHPRC is currently contracted to the Department of Energy (DOE) to remediate contaminated sites at the Hanford Site. Hundreds of waste sites have been identified on the Hanford Site, making Hanford the largest Superfund Site in the United States. Many of these contaminated waste sites were created during the Manhattan Project and the Cold War era when Hanford produced plutonium for nuclear weapons. Radioactive materials were released into soil columns intentionally as a form of disposal, and there were uncontrolled releases to the environment. Other waste sites were targeted for remediation because they were the sites of reactors and processing facilities. The contaminated soil and debris removed during site remediation are disposed of at the Environmental Restoration Disposal Facility (ERDF) on the Hanford Site.

The ERDF was established as an engineered disposal facility specifically for the waste removed from the remediation areas. This large landfill, which is regulated by the U.S. Environmental Protection Agency (EPA), accepts low-level radioactive, hazardous, and mixed wastes and disposes of them below grade into excavated areas called cells.

The disposal cells at ERDF have an engineered liner below each cell. The liner is designed to prevent any liquid precipitation from leaching through the waste and then entering into the groundwater. The liner that is below each cell prevents leaching by collecting the liquid and routing the liquid to a collection tank. The liquid is then transferred to a treatment facility on the Hanford Site. After treatment, the liquid is clean enough to be released to the ground with no harm to the environment.

The disposal costs of material removed from waste sites is a major cost in the clean-up effort. Disposal costs are often the most expensive portion of the project; therefore, survey methods capable of accurately determining how much waste material needs to be removed and disposed of at ERDF could greatly reduce disposal costs.

SURVEY METHODS

Scoping surveys are performed at the beginning of outdoor remediation projects to determine the extent and magnitude of the contamination. For example, an area of approximately (13 acres) was chosen as the starting point for the BC-controlled area remediation. A sodium iodide (NaI) detector was used to perform the scoping survey. The NaI detector logged gross counts per second (GCPS) along with the latitude and longitude coordinates for the measurement. The results of the survey are shown in Fig. 1.

The results of the survey show a relatively large number of isolated areas of contamination requiring remediation. Soil sampling was performed to confirm the presence of IOCs above the cleanup limits. The sampling results showed that only one of the areas identified contained IOCs above the cleanup level. This prompted CHPRC personnel to inquire into the use of real-time spectrometers for screening areas to be remediated. At the time the project began, no isotope identifiers were capable of performing the function of logging a suite of gamma-emitting isotopes and simultaneous GCPS along with latitude and longitude coordinates. In addition to this feature, the need for a feature to alarm on an individual isotopic peak at a manually set alarm point was identified to support active remediation. The BNC agreed to work with CHPRC to modify their existing SAM-940 to incorporate these functions.
THE INSTRUMENT

The instrumentation has been designed to notify the user of the presence of an isotope of concern above a set threshold. The information is used to drive targeted cleanup. The ability of the instrument to be integrated with GPS technology and log data, provide a record of the measurements taken along with time and date stamp and location of the measurement with sub-meter accuracy. The GCPS data along with isotopic information is stored on an internal flash card. The flash card can be removed from the instrument and read with a standard card reader. The format of the data from the card can then be converted to an excel file (Fig. 2).

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Note: This is only a partial list of Isotopes in the identification library.

Fig. 2. SAM-940 Data Converted to Excel Format
When the SAM-940 is operated in a mode intended for finding IOCs, a sigma trigger level can be set to notify the user when that isotope or set of isotopes is found (Fig. 3). The sigma trigger is adjustable depending on the cleanup criteria for the location. For example if the background count rate was 9 cps, and the cleanup criteria was five times background (45 cps for an IOC), then the sigma trigger could be set at 8, which would notify you when the IOCs count rate was
\[ \sqrt{9 \times 8} = 24 + 9 = 33 \text{ cps} \]

Most remediation standards are written as volumetric measurements. To infer volumetric measurements would obviously require a standard geometry, development of MDAs, field of view, and other parameters. But when used as a screening tool for targeting cleanup areas, the SAM-940 has proven to be accurate in locating areas containing IOCs requiring remediation. To date, all of the sites scanned and determined by the instrument to be below the IOC trigger level, has been manually sampled and shown to be clean.

The instrument also has the ability to display multiple IOCs simultaneously to identify multiple hazards. This is extremely useful when performing release surveys of materials with inaccessible surfaces. A survey that is representative of inaccessible areas can be checked with the isotope identifier to add a degree of confidence that materials being released are free of contamination.

**MAPPING OF RESULTS**

The ability to map the results of a survey is beneficial for both surveying and post processing of data. While the instrument logs the measurements during a survey, the surveyor can direct visual attention to other hazards that may require remediation, resulting in a safer and more thorough survey. The data can be reviewed after the survey is complete to determine the areas requiring remediation. The SAM-940 instrument generates a map that shows the survey of a waste site that has been remediated revealing spots that contain remnants of contaminants that may require further remediation. Soil sampling of the area determines if remediation is complete and if the site has met the cleanup criteria.

The maps provide a permanent record that can be attached to the survey record. The maps can also be disseminated to management and the customer to show progress of the cleanup.

Fig. 3. Screen Shot of SAM-940 BARS Mode with Sigma Trigger

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The CHPRC has developed an internal web page that contains all the mapping from gamma surveys. This includes surveys done by other means such as aerial surveys. The web site also is linked to the historical information about each site to be cleaned including boundaries, IOCs, photographs, and the chronological history of the site.

The maps are displayed on a web-based geospatial data portal. The system combines the following technologies: Esri ArcGIS™ server, Esri ArcIMS™¹, GeoNorth MapOptix™², and Custom Code³. The built-in tools allow the user to markup, measure distances, measure area, and add additional layers for tracking remediation progress over time. The technology allows planning of work activities by providing latitudinal and longitudinal coordinates, size of contaminated area, and magnitude of contamination.

MOBILE SYSTEM

The CHPRC has worked in collaboration with BNC; Nuclear Securities Technologies LLC of Las Vegas, Nevada; and HiLine Engineering of Richland, Washington, to develop a mobile platform for the SAM-940. The mobile unit has a SAM-940 instrument equipped with a 4x4x16 NaI detector mounted on a Kubota with a hydrostatic transmission (Fig. 4). The Kubota is powered with a three-cylinder diesel motor for operation off road to reduce fire hazards. The hydrostatic transmission allows more stable speed control of the instrument. The NaI detector is housed in an engineered box and mounted on the rear of the vehicle with hydraulic controls for raising and lowering the detector to adjust field of view and sensitivity to point sources.

![Fig. 4. Mobile Survey System](image)

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¹ ArcGIS and ArcIMS are trademarked products owned by Esri of Redlands, CA.
² MapOptix is a trademarked product of GeoNorth, LLC, of Anchorage, AK, and Portland, OR.
³ Custom Code is a serial port chip tuning technology owned by Custom-Code of Chesterfield, Derbyshire, UK.
A custom mapping option was developed by BNC and CHPRC that allows the mapping of all 256 channels within the spectrum individually. When this option is selected as active, a time and date stamp, GPS coordinates, GCPS, and spectrum data are all mapped simultaneously.

The mobile system has undergone characterization of the NaI detector to develop algorithms necessary to perform volumetric conversions. The system will be used along with limited soil sampling to provide enough information for regulators to determine that a site has been remediated and meets cleanup criteria.

Another use of the mobile system will be in performing large area surveys and mapping the results of the surveys. During remediation activities, there often are very large radiological buffer areas adjacent to the work site that must be routinely surveyed. The instrument can economically provide a 100 percent survey of the area to accompany limited direct and transferability measurements.

The mobile system also can perform scans of suspect areas and provide reliable documented data about the condition of the area and the exact location of the IOCs that are present. The instrument can be used in support of remediation by scanning large areas and immediately identifying areas requiring further remediation.

Another potential use for the instrument is in response to abnormal events; for example, if an incident involving uncontrolled release of radioactive material or transportation of radioactive materials occurs, the mobile survey system can efficiently scan the suspect release areas to provide confidence of a non-release, or to identify a release and isolate the areas for clean-up.

CONCLUSION

The information provided by real-time spectroscopy can give remediation organizations the ability to more accurately target contaminated areas for cleanup, reducing unnecessary impact to the environment, and reduce the amount of material requiring disposal and the associated cost. In addition, the capability to target specific areas for cleanup may reduce the time required to remediate a waste site.

The versatility of the instrumentation makes multiple uses practical. The instrument provides qualitative data that can drive specific actions in radiological situations. The ability of the instrument to provide full-spectrum real-time data makes quantitative measurements possible and can greatly reduce sampling time and costs.