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INTERSTATE TEHCNOLOGY & REGULATORY COUNCIL

Real-Time Measurement of Radionuclides in Soil: Technology and Case Studies (RAD-4)

EXECUTIVE SUMMARY

In recent years, new options for measuring contaminant levels in real time at radioactively contaminated sites have emerged. In addition to improved technologies and the accumulation of field experience, the overall management and planning philosophy has evolved to the point that it can now be integrated with the technological improvements. As a consequence, paradigm-shifting alternative approaches that offer significant reductions in costs, dependable accelerations in schedule, and major improvements in reliability are now available. While these real-time radiological characterization techniques were developed to assist with site cleanups under environmental regulations, these technologies would be equally applicable to radiological characterization activities in the aftermath of a radiological dispersion device (improvised nuclear device or “dirty bomb”).

Real-time measurement systems allow radionuclides in both surface and subsurface soil to be measured more rapidly than they can be with traditional sampling approaches. The basic technologies for these real-time systems are two different types of solid-crystal gamma detectors: sodium iodide and germanium. Understanding the advantages and limitations of each is an important consideration when planning a real-time survey. When these instruments are combined with new location technologies, the ability of real-time measurement systems to present data in an immediately useful format is greatly enhanced. Some of the new positioning technologies provide accuracy down to a sub-centimeter level and can allow for three dimensional location control during excavation. As a further enhancement, the detectors and location devices have been mounted on various platforms to make data acquisition convenient to the specific needs at different sites. These platforms range from hand-pushed carts to tractors to excavators and even to direct-push samplers for characterizing subsurface soils.

The real rewards of technical advances in field instrumentation come when the technologies realize synergies with data collection methodologies and decision frameworks. Two different but complementary tools, the Triad approach and Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), provide these methodologies and frameworks. Triad is an approach to data collection and decision-making that rests on three legs: systematic planning, dynamic work plans and real time measurement. MARSSIM provides detailed guidance on planning, implementing, and evaluating environmental and facility radiological surveys. These surveys are specific to radiological contamination and are aimed at demonstrating compliance with regulations during the final status survey after remediation has been completed. Both MARSSIM and Triad address the management of uncertainty in the decision-making process. These similarities allow both Triad and MARSSIM to be used with real-time measurement techniques to develop protocols for efficient site characterization and closure

Real-time measurement systems can support the various phases of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) process: preliminary assessment, remedial investigation/feasibility study, and remedial action. Combined with more traditional discrete sample collection, real-time measurement systems can provide critical support for a number of key activities in the CERCLA remedial decision-making process particularly the management of uncertainty. Other issues that frequently complicate characterization and remediation activities include large areas, the presence of other

contaminants, the presence of buried contamination, inadequate prior characterization, and the presence of hotspots.

Real-time gamma data collected in support of soil remediation must meet the data quality and documentation requirements of the appropriate regulatory program, typically CERCLA or Nuclear Regulatory Commission decommissioning. Quality assurance and quality control (QA/QC) for real-time measurement systems focus on different sources of uncertainty than traditional sampling methods. Uncertainty due to limited coverage and spatial variability is reduced, but inferential and analytical measurement uncertainty become more important than with discrete sampling. Since real-time measurement systems do not have well-established performance parameters, it is important to carefully set up a QA/QC program that fits the radiological constituents being measured, the performance capabilities of the measurement system, and the site characteristics. Important factors to consider include essential performance requirements (such as energy of gamma rays, identity of surrogate or progeny nuclides, identity of interfering gamma rays), conditions and contexts of soils (including soil moisture, topography, and measurement geometry), and contaminant distribution (deviation from uniform distribution, lateral inhomogeneities, etc.).

A few regulatory and stakeholder issues have emerged from the limited number of deployments of real-time measurement systems. Real-time measurements have become widely accepted for characterization and remedial phases at most sites; however, the use of these technologies has generally not been allowed for final certification purposes. While the physical sampling and statistical analyses performed for non-radionuclides have well-established protocols that are familiar to most regulators and stakeholders, the protocols and data presentations for real-time radiological surveys are not. Communicating to stakeholders the results from these surveys and the associated risks will require explanations different than those used for traditional sampling techniques.

Real-time radiological data collection techniques have now been used at several sites so that the collected experiences can be evaluated for future users. Case studies document the applications of the detectors on various platforms, on various terrains, measuring different contaminants in combination with dynamic work plans. These case studies confirm that cost savings can be realized by utilizing real-time survey methods in characterization, remediation, and verification phases of the cleanup process.