INEEL/CON-99-01323
PREPRINT

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

In-Situ Site Characterization Technologies Demonstrated at the INEEL in Decommissioning Projects

K. C. Wright
R. Meservey
L. Whitmill

April 2, 1999 – April 7, 1999

8th International Conference on Nuclear Engineering (ICONE 8)

Proceedings of ICONE 8
8th International Conference on Nuclear Engineering
April 2-6, 2000, Baltimore, MD USA

IN-SITU SITE CHARACTERIZATION TECHNOLOGIES DEMONSTRATED AT THE INEEL IN DECOMMISSIONING PROJECTS

Kelly C. Wright
Idaho National Engineering & Environmental Laboratory
P.O. Box 1625
Idaho Falls, ID 83415-3720
Phone (208)526-2299
Fax: (208)526-2448
Email: wck@inel.gov

Richard Meservey
Idaho National Engineering & Environmental Laboratory
P.O. Box 1625
Idaho Falls, ID 83415-3710
Phone (208)526-1834
Fax: (208)526-6802
Email: rhm@inel.gov

Larry Whitmill
Idaho National Engineering & Environmental Laboratory
P.O. Box 1625
Idaho Falls, ID 83415-3765
Phone (208)526-0357
Fax: (208)526-0425
Email: wit@inel.gov

ABSTRACT

The United States Department of Energy (DOE) continually seeks safer, more cost-effective, and better performing technologies for decontamination and decommissioning (D&D) of nuclear facilities. The Deactivation and Decommissioning Focus Area (DDFA) of the DOE Federal Energy Technology Center (FETC) sponsors Large Scale Demonstration and Deployment Projects (LSDDPs) which are conducted at various DOE sites. The Idaho National Engineering and Environmental Laboratory (INEEL) is one of the DOE sites for demonstration of these new and improved technologies. The INEEL needs statement defines specific needs or problems for their D&D program. One of the needs identified at the INEEL was for new or improved site characterization technologies.

A variety of in-situ site characterization technologies have been demonstrated through the INEEL LSDDP. These technologies provide a safer means of characterization, improved documentation, real-time information, improved D&D schedules, and reduction in costs and radiation exposures to workers. These technologies have provided vast improvements to the D&D site characterizations. Some of these technologies include:

- The Global Positioning Radiometric Scanner System for large-area, surface gamma radiation surveys
- Remote underwater characterization system
- Identifying heavy metals in painted surfaces and determining the alloy composition in metallic material
- In-Situ Object Counting System for free release
- Real-time radiological data acquisition with the Surveillance and Measurement's sodium iodide detector
- Electromagnetic radiography to locate contaminated soils.

Historically, site characterization has been a slow, costly, and tedious process. However, through these demonstrations, new technologies have provided more accurate data, real-time information, and enhanced site characterization documentation. In addition, a safer work environment has been established as a result of decreasing the worker's time (exposure) in contaminated areas. Furthermore, D&D schedules are shortened considerably. This results in a tremendous cost saving to the D&D program.

INTRODUCTION

As one of four major focus areas within the DOE Office of Science and Technology (EM-50), the D&D Focus Area (DDFA) is responsible for developing, demonstrating, implementing cost-effective and safe technologies. The DOE has a need complex-wide to deactivate approximately 7,000 contaminated buildings and to decommission approximately 700 contaminated buildings that are currently on the list of surplus facilities. Deactivation refers to ceasing facility operations and placing the facility in a safe and stable condition to prevent unacceptable exposure to people or the environment to radioactive or other hazardous materials until it can be decommissioned. Typically, deactivation involves removal of fuel and stored radioactive and other hazardous materials. Decommissioning is the process of decontaminating or removing contaminated equipment and structures to achieve the D&D objectives for the facility. This includes complete removal and remediation of the facility, facility entombment, and release of facility for restricted or unrestricted use.

Ultimately, the goal of the DDFA is to commercialize this new innovative technology so that it will be available to potential end users at a competitive price. A key phase in technology development is "demonstration" of this technology to these potential end users. Technologies reaching the demonstration stage should have clear end user support for the demonstration; firm cost-sharing arrangements and partnership agreements; and resolution of technical, safety, regulatory, public, and intellectual property issues. It is the intent of the DDFA to conduct technology demonstrations at DOE facilities on a scale and test duration that is convincing to potential end users. Data from the technology demonstration provides potential end users with sufficient information needed to make decisions regarding subsequent use of the technology. Primary end users are the DOE Office of Environmental Restoration (EM-40).

In general, sufficient baseline technologies exist to deactivate and decommission the DOE surplus buildings, structures, and their contents. However, in general, baseline technologies are commonly labor intensive, time consuming, expensive, and result in excessively exposing workers to radioactive and other hazardous materials. Additionally, many baseline technologies also generate secondary waste beyond those of the D&D operations.

The DDFA addressed these problems by developing, demonstrating, and facilitating deployment of technologies that generated less waste, were lower in cost, required less labor, reduced personnel exposure to radioactivity and other hazardous materials, and improved worker safety. Innovative technologies are being developed for characterization of contamination, decontamination of buildings and materials, pollution prevention, waste minimization, and increased worker safety.

At the INEEL, the D&D LSDDP identified appropriate advanced technologies for inspecting, characterizing, and decontaminating some of the INEEL facilities. In addition, new innovative technologies have been demonstrated alongside the established baseline technologies normally operated during conventional D&D activities. Performance indicators such as requirements, cost, effectiveness, implementation, worker exposure, and waste generation were measured and summarized for each technology demonstrated.

As part of the LSDDP at the INEEL, a variety of in-situ characterization technologies have been demonstrated. These technologies have: provided a safer characterization process, improved the documentation, added real-time information, improved D&D operation schedules, added cost reductions, and provided a way for reducing worker exposures. Some of these in-situ technologies demonstrated at the INEEL are:

- The Global Positioning Radiometric Scanner (GPRS) System for conducting large-area, surface gamma radiation surveys
- The Remote Underwater Characterization System (RUCS) for characterizing and inspecting underwater reactors and fuel storage pools
- Identifying heavy metals in painted surfaces and determining the alloy composition of metallic material
- In-Situ Object Counting System (ISOCS) used for free release
- Real-time radiological data acquisition using a Surveillance and Measurement (SAM) with a sodium iodide probe
- Electromagnetic radiography to locate contaminated soils.

INEEL DEMONSTRATIONS

All technologies proposed are evaluated as candidates for demonstration. Technologies are solicited through requests in public documents, advertising, and Internet communications or by personal contact with vendors, other LSDDPs, end-users, etc. Approval of a technology by the Integrating Contractor Team (IC Team) is not a guarantee that the technology will be demonstrated. For instance, a technology may not be demonstrated because of issues associated with the budget, schedule, procurement, or site priorities.

Figure 1. The Global Positioning Radiometric Scanner System

Once a technology has been approved for demonstration, both technologies (i.e., baseline and the new innovative) are evaluated side by side as part of the ongoing D&D operations. These evaluations are performed under field conditions for a sufficient duration to provide convincing data of the benefits obtainable through the deployment of the innovative technology. This evaluation will provide validation of any perceived or advertised benefit and a level of confidence for the risk associated with equipment failure or operator handling.

Global Positioning Radiometric Scanner System

The INEEL has D&D facilities no longer in use, but before a facility or the land once occupied by that facility can be remediated or turned over for reuse, it must be characterized for radiological contamination. To do this, a statistical grid is marked off, and surveyed by personnel using hand-held instruments to characterize the radiological contamination. Baseline technology can sometimes be a labor-intensive effort. A more cost effective survey methodology was needed for both characterization and final releases phases of the D&D Program.

The Global Positioning Radiometric Scanner (GPRS) includes a radiological detection system, portable computer, differential global positioning system (d-gps providing real-time corrected positioning information), and a four-wheel drive vehicle (shown in Figure 1). The detection system consists of two 4 in. x 26 in. x 1.5 in. plastic scintillators housed in an 8 in. x 8 in. x 72 in. white enamel steel box. One controller adjusts the upper and lower detection limits on both scintillators simultaneously. Each detector is shielded with 1/8 in. of lead on the top and sides allowing only measurement data directly below the system to be gathered. The detectors are mounted on the front of the four-wheel drive vehicle at a height of 3 ft.

During operation, the detector interfaces with the portable computer and displays the following information: gamma radiometric data (counts per second for each detector), geographical data (latitude and longitude coordinates), time, date, and altitude. The on-screen display is helpful in tracking the areas that have been surveyed (shown in Figure 2). The on-board portable computer records the gamma radiometric data and the associated geographical coordinates in memory.

The software program generates a graphical representation of the data to visually identify the extent of contamination in an area. This technology has been proven to be very effective in operating in adverse terrain and providing real-time characterization information.

The INEEL demonstrated the GPRS in September 1999. This demonstration took place at the Initial Engine Test (IET) Facility on the IET stack trench, an area approximately 80 ft. x 100 ft. The IET stack was slightly contaminated and was knocked over into a trench as part of the D&D efforts. The trench was then covered with soil to provide a radiological barrier. Prior to releasing the area to the Environmental Restoration Program, D&D Operations must characterize and map the area (as shown in Figure 3). The gridded area was surveyed by both technologies, and the results were compared.

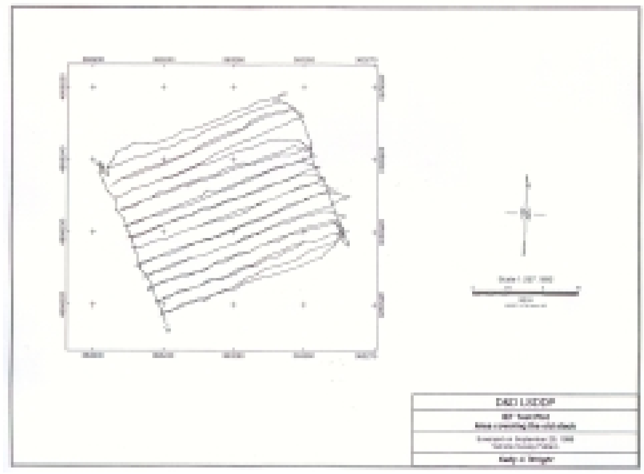

Figure 2: On Screening Tracking

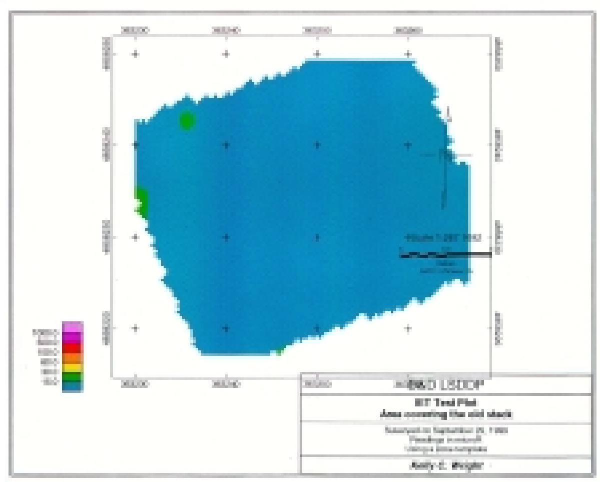

Figure 3. The GPRS Results from the IET trench area survey

The hand survey required 65 minutes in comparison to the 15 minutes required for the GPRS survey, saving 77% in labor hours alone. Comparing the data, the hand survey results were simply stated as a range from 10-20 microRem per hour. The GPRS results included radiometric data (counts per second for each of the individual detectors), geographical data (both latitude and longitude coordinates), altitude, time, and date. This information was stored in an onboard computer and was updated approximately every two seconds. As a result, more valuable detailed and accurate information was recorded by the GPRS for characterization of this area.

Remote Underwater Characterization System

Characterization and inspection of water-cooled and moderated nuclear reactors and fuel storage pools required characterization and inspection equipment capable of operating underwater. This equipment is often required to operate at depths exceeding 20 ft and in relatively confined spaces. The use of baseline technologies consisted of radiation detectors (GM) and underwater cameras mounted on long poles or stationary cameras with pan and tilt features mounted on the sides of the underwater facility. A need for a more mobile method of performing close-up inspections and radiation measurements was identified for underwater applications.

Figure 4: The RUCS

The remote underwater characterization system (RUCS) is a small, remotely operated submersible vehicle (shown in Figure 4) intended to serve multiple purposes underwater in D&D operations. "Scallop[1]", a commercially available vehicle produced by Inuktun Services Ltd., British Columbia, Canada, was modified by the INEEL Robotics Technology Development Program. They added an auto-depth control, vehicle orientation, and depth monitoring capabilities on the operator control panel. The RUCS is designed to provide visual and gamma radiation characterization, even in confined or limited access areas. It utilizes a forward-looking tilt color camera and a GM tube to get real-time, "on-the spot" radiological information.

The RUCS was demonstrated in August 1998. The demonstration took place in a canal containing two de-fueled test reactors at the Test Reactor Area (TRA-660) facility (shown in Figure 5). The RUCS was used to visually survey the canal and its contents, and also to gather radiological characterization data on the reactors and equipment on the floor of the canal.

The RUCS was easier to deploy than the underwater camera or underwater radiation detector on a long (15 ft – 20 ft)

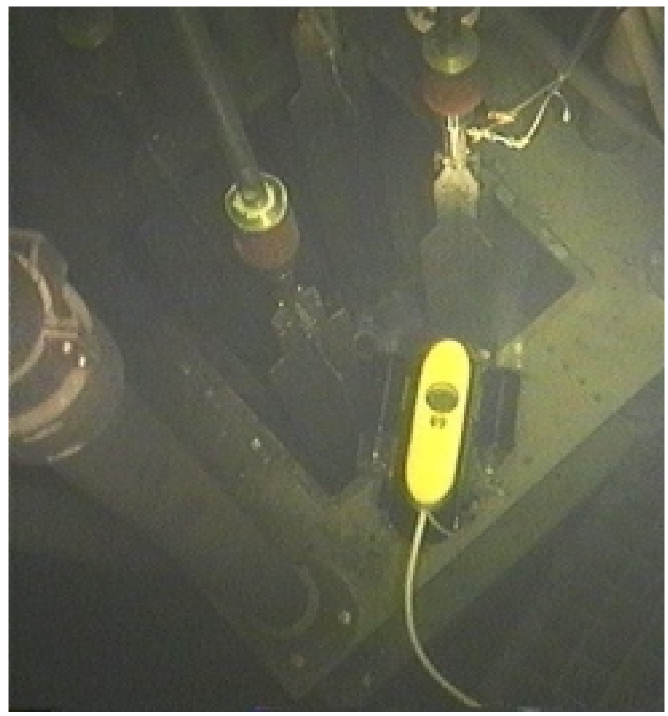

Figure 5. RUCS Inspecting A Control Rod On The ARMF Reactor.

reach rod. In addition, the number of personnel requiring to be suited up in personal protective equipment was reduced. This saved labor costs and reduced the potential for worker exposure or contamination. Its relative small size and maneuverability allowed to it operate beneath overhead structures and behind the reactors. In some instances, it measured radiation levels 50% higher than previously known simply by its ability to get closer to the object. However, it should be noted that this technology is not entirely superior in all instances. For instance, baseline technology provided a better quality of video footage and was more flexible in obtaining access to areas

[1] [1]References herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof.

inside of pipes. Ultimately, both technologies compliment one another and would be very beneficial to D&D operations.

Lead Paint Analyzer

A need existed at the INEEL for in-situ, real-time analysis for identifying and quantifying lead, cadmium, chromium and other metals in painted surfaces. Baseline technology required collecting paint chips from a surface, packaging, and shipping the sample to the laboratory for analyses. Typically, analytical costs were approximately $1000 per sample and generally took up to 90 days to get the data back.

The Niton Series 700 analyzer is an 8 in. x 3 in. x 2 in. hand held, battery-operated unit that weighs approximately 2.5 pounds (shown in Figure 6). The analyzer uses X-ray fluorescence (XRF) spectrum analysis for identifying and quantifying metals in paint. All eight of the Resource Conservation and Recovery Act (RCRA) metals and 17 other different alloys can be characterized within seconds. The analyzer uses two different radioactive sources. An Americium-241 source is used to detect antimony, barium, cadmium, indium, iodine, palladium, silver, and tin. The second source, Cadmium-109, is used to detect arsenic, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, rubidium, selenium, strontium, titanium, zinc, and zirconium.

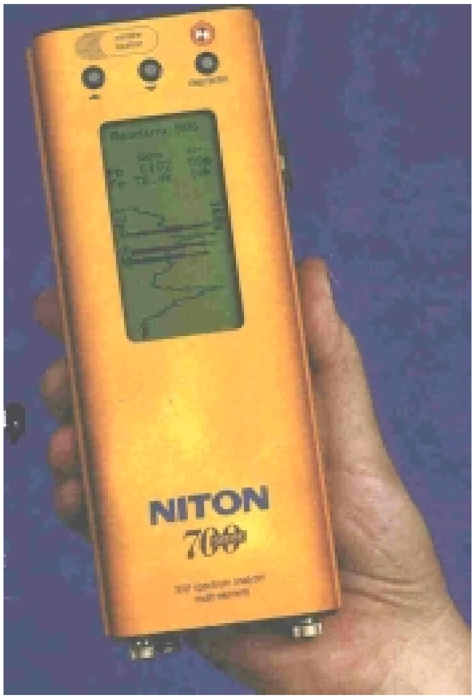

Figure 6. The Lead Paint Analyzer (LPA).

The batteries are good for at least 8 hours and re-charge in less than 2 hours. The system can store up to 3,000 different data sets, including the sample locations. By placing the analyzer against a painted surface, the shutter window opens allowing the detector to analyze the surface. The analyzer begins to beep at 20 second and then displays the results. The analyzer data can be easily downloaded to a conventional personal computer or even a laptop computer to expedite the data interpretation process.

The LPA was demonstrated in February 1999. The technology was demonstrated at three different INEEL facilities. It was used to identify and quantify metals in paint (shown in Figure 7). Paint samples were collected and sent to a laboratory for analysis for comparison with the LPA results. The equipment was calibrated several different times (i.e., in the laboratory, in the field prior to taking any measurements, periodically during the data collection, and at the conclusion of the demonstration).

The results generated by the LPA were confirmed by laboratory analysis. Theoretically, the LPA data were more precise than the analytical results because the sample collection methodology could have resulted in cross-contaminating the sample. One important aspect of this comparison was the fact that the LPA measurements were made within 20 seconds compared to the baseline technology of collecting samples and waiting up to 90 days to get the data back. According to the sampling crew, this technology was user-friendly, easier to operate, and required no bias in collecting or locating sample measurements. The analytical data obtained from the LPA is reported in mg/cm^2. Therefore, the operator may be required to convert the results into other different units depending on the application.

Figure 7. The LPA (Niton Series 700) Collecting a Surface Measurement.

This LPA will reduce analytical costs and shorten the D&D schedules. Schedules are shortened because data are available immediately allowing clean-up decisions to be made in the field. Due to the tremendous benefits associated with this technology, the INEEL believes that this technology will be deployed immediately into D&D operations.

Alloy Analyzer (Niton Series 800)

At the INEEL there is a need for in-situ, real-time analysis in identifying the alloy and chemical composition of metallic materials found during D&D operations. This in-situ, real-time analysis should provide the information necessary for segregating metals for recycling, selecting cutting tools, and identifying the potential for leaching RCRA listed metals (i.e., Chromium).

The current method involves collecting samples and shipping them to a laboratory for analysis. The costs could be approximately $4,500 per sample and take up to 60 days to receive the laboratory results.

Figure 8. The NITON Series 800 Multi-Element Spectrum Analyzer with bar code template and shielded belt pouch

The NITON Series 800 analyzer (Alloy Analyzer, shown in Figure 8) is an 8 in. x 3 in. x 2-in. hand-held, battery-operated unit that weighs approximately 2.5 pounds. The batteries are usable for at least 8 hours and are re-charged in approximately 2 hours. The Alloy analyzer uses XRF spectrum analysis to identify and quantify elements in metal and compares the measurement with a built-in library to determine the alloy. The library contains 300 elements and alloys and has the ability to be customized. This technology also has the potential to be calibrated to two different sources. The Alloy Analyzer can use a Cadmium-109 source for the same evaluation of elements listed with the LPA. However, the vendor is currently developing another source for this technology using either Iron-55 or Americium-241. Iron-55 will provide greater sensitivity range between Silicon-16 to Chromium-24, while the Americium-241 will provide a greater sensitivity range between Rhodium-45 to Terbium-66.

This technology operates in the same fashion as the LPA except a safety button on the side of the analyzer must be pushed before the shutter window opens. Another improvement with this technology is the analyzer can be set-up to beep at 5, 20, and 60-second intervals. Once the Alloy analyzer is removed from the surface, the results will be displayed. As the length of time increases for the analysis process, the more accurate the result becomes. This analyzer can only store up to 1,000 different data sets. However, it has the capability of using a bar code reader for the sample identification codes. Again, this data is also easily downloaded to a conventional personal computer or portable laptop computer. The Alloy analyzer is a surface scanner technology. Therefore, coatings can adversely affect the measurements, this technology may require some surface preparations (i.e., wiping the surface clean, scraping the paint, grinding off a coating) in order to obtain an accurate measurement.

Figure 9. Alloy analyzer making a measurement on piping in the PBF

The Alloy analyzer was demonstrated in June 1999. It was used to characterize metal (shown in Figure 9) and to demonstrate the ability to make field identification for the segregation of scrap metal. The Alloy analyzer performs a self-calibration at startup and is periodically checked using a Quality Assurance (QA) sample to ensure the instrument accuracy.

At the completion of each phase of this demonstration, the analyzer data was downloaded to a personal computer. At the completion of the demonstration, the analyzer results were compared to drawings and any other records containing information about the composition of the material. In addition, these results were compared to Certified Material Test Reports (CMTRs) when available. The CMTRs confirmed the Alloy analyzer element measurements. The analyzer correctly identified known alloys 96% of the time. This technology determines the alloy by comparing selected element to its library. This NITON technology is also user friendly and easy to operate. The results from this instrumentation are reported in percent by weight concentration (the standard measurement for metal alloy composition). These results can also be used by the D&D personnel to make immediate decisions selected for handling the materials (i.e., appropriate method for cutting or removing, and identifying precious metals). In addition, this technology would assist the D&D operators in identifying unknown or suspect material at a reasonable cost. Again, the INEEL believes that this technology provides tremendous benefits to the D&D operations and will likely be deployed immediately in the D&D programs.

In-Situ Object Counting System

A need was identified for characterizing buildings or areas to meet the unrestricted release criteria. In addition, this technology must also be able to reduce costs, worker exposures, and accelerate work schedules. Currently, the criteria for unrestricted release requires the room be surveyed before it can be free released. This requires a radiological control technician (RCT) to grid the rooms (floor, walls, and ceiling) into 1 m^2 areas and manually survey each of them. If the survey area does not meet the unrestricted release limits, the entire 1 m^2 grid will be disposed of as a hazardous waste.

An In-Situ Object Counting System [(ISOCS) shown in Figure 10] was used with the following equipment to provide free release for this demonstration. It included:

- 55% efficiency germanium detector with a portable liquid nitrogen cryostat [a 7 day Big Mac (doer)]
- battery or AC powered InSpector (a portable spectroscopy analyzer)
- adjustable collimator (shield)
- laptop computer with Canberra's software (i.e., Genie-2000 and PROcount)
- portable cart for holding the detector along with the associated shielding.

ISOCS has been mathematically calibrated using the Monte Carlo process to perform a variety of efficiency calculations for a wide variety of shapes, sizes, densities, and distances between the detector and the area of interest. For this demonstration, an important assumption about the field of view must be made, the room must be considered to homogeneous. By this, we are assuming the floor, walls and ceiling have the same potential for contamination.

Another important feature of this technology is the ability to operate with a collimator to assist in locating where the contamination may be on a wall, floor or ceiling. For this demonstration, the ISOCS will be operated both with and without the collimator to evaluate the systems ability for locating the contamination. All measurements collected from the ISOCS will be evaluated against the derived concentration guide values established in "Development of Criteria for Release of Idaho National Engineering Laboratory Sites Following Decontamination and Decommissioning," August 1986 (EGG-2400).

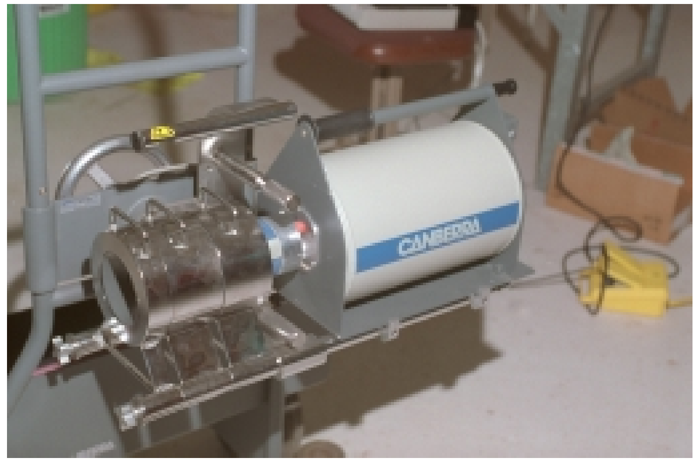

Figure 10. ISOCS system identifying different area of contamination.

For further information on another DOE application using the ISOCS system for the characterization process, the Innovative Technology Summary Report, "Chicago Pile 5 (CP-5) Research Reactor Large Scale Demonstration Project", discusses the demonstration conducted by Argonne National Laboratory-East.

So far, we have characterized a room more efficiently than the baseline technology. At a room in the Central Facilities Area old laundry (CFA-617), the ISOCS system was able to characterize and identify contamination in one hour compared to the baseline technology needed almost 40 hours to get the same results. Another benefit from using the ISOCS is the system can be set-up and left unattended while it is performing the analyses. This also results in accelerating the D&D schedule by freeing up the worker and allowing additional tasks to be completed. It is important to keep in mind that this technology has not been completely demonstrated at the time of this paper, but if any additional benefits or problems are identified, they will be discussed at the conference.

Surveillance and Measurement system

A need addressing the identification, quantification, and removal of radiological contamination was recognized at the INEEL. Characterization of a site can be a slow and tedious process. Currently, many of the screening and surveying activities are slowed down due to the long acquisition and analysis times, resulting in delayed D&D activities. Historically, area surveys were conducted using hand-held monitors and required collecting samples for analytical analyses to provide isotopical identification of the radionuclides. An adequately characterized area requires detailed surveys and collection of samples for analysis. This could result in numerous hours gathering the necessary data and high costs associated with the analytical results.

The Surveillance and Measurement System (SAM, shown in Figure 11) combines sodium iodide (NaI) spectroscopy with proprietary enhancements. By utilizing time slicing and data compression techniques, the SAM provides shorter acquisition times, accurate quantification, and spectroscopic identification. Isotopic identification can be made within a second either stationary or in motion. Quadratic Compression Conversion is the data compression technology used to enhance the identification process of the algorithm. This feature allows the operator the ability to identify multiple isotopes in the one-second interval while another spectra can be accumulated. The SAM can be operated in high background environments and still be able to provide accurate isotopic information.

Figure 11. The SAM Model 935 With an Internal NaI probe

SAM provides the operator four different modes of operation: easy, detail, Multi-channel Analyzer (MCA), and surveillance. The easy mode displays the strength and alarm status of identified isotopes in real time. The detail mode presents the current data spectrum in real time as well. The MCA provides two different features: the data acquisition and the analysis in pulse height. If the operator does not have a technical background or the need for this information, this mode can be protected. Finally, the surveillance mode displays the isotopic specific dose rate and has the ability to categorize the contributing isotopes with their specific dose rate.

This technology has not been demonstrated yet, but by the time of the presentation the advantages or disadvantages will have been identified. However, the author(s) believe that this system could provide essential real-time information for assisting the D&D operations to ensure they are on-schedule and possibly even accelerated. The SAM could also help in reducing costs associated with collecting and analyzing the data to quantify the radiological contamination.

Electromagnetic Radiography

A need has been identified for a characterization method of identifying soil contaminants, providing more detailed information about the site, reducing costs, and reducing worker exposures. Currently, the baseline technology requires boring samples for characterization, and field test kits for guidance during excavation activities to identify soil contaminants. If contaminants are suspected or known within an area, bore-samples are statistically located within the sample area. Another sampling method used during excavation is simply "sample-as-you-go" to assist with determining the extent of the plumes of contamination. Both of these methods are rather labor intensive, very expensive, and not fairly accurate in locating the extent of the contamination.

Electromagnetic Radiography (EMR) is a next generation ground penetrating radar system used to perform 100% examination of a soil area (see Figure 12). EMR is designed to identify, in three-dimensional representation, subsurface soil anomalies caused by chemical contamination with minimal surface soil disturbance, employee exposure, and personal protective equipment usage. The cost for the EMR is dependent on the target objects being identified, type of terrain, and the total area being surveyed. An approximate cost per acre is somewhere between $5,000 to $12,000 dollars depending upon the different variables. In addition, the EMR is capable of locating buried solid objects (i.e., piping, drums, tanks, etc.). However, due to the complicated post-data processing associated with the buried solid objects, the preferred application for the EMR is detecting contaminants in soil.

The EMR was demonstrated during April 1999, in three different locations at two different facilities [i.e., the Initial Engine Test (IET) facility and the Idaho Nuclear Technology and Engineering Center (INTEC)]. At IET, the EMR investigated the potential for two different soil contaminants. The first was mercury along the old railroad bed, and the second one was a petroleum product in an area with known contamination caused from a leak along a fuel supply line. Both locations covered an area approximately 10,000 ft^2. At

Figure 12. The EMR Antenna and Tow Vehicle, Typical Large Area Survey Setup.

INTEC, the EMR was deployed to locate buried piping. This area was somewhat larger than at IET covering approximately 60,000 ft^2.

The EMR provided 100% coverage of all the surveyed areas, a vast improvement from either of the baseline technologies used for characterizing soil areas. At IET along the railroad bed, preliminary results indicated the presence of a dense, non-aqueous phase liquid (DNAPL) believed to be mercury. This DNAPL was identified at several different areas, relatively small in size (1 to 4 ft in diameter). However, another contaminant was identified as light non-aqueous phase liquid (LNAPL). This was unexpected for this area since LNAPL is believed to be more attributed to petroleum products (i.e., fuel oil). The LNAPL was identified only in one area along the railroad beds and was approximately 8 ft by 15 ft. Further investigations are being conducted by collecting additional samples to analyze and by providing a more detail analyses with the information already collected by the vendor to help verify or validate the initial results found at these locations. At the IET known contaminated (fuel leak) area, preliminary results have indicated the presence of LNAPL is believed to be fuel oil found along the supply line running from Test Area North facility to IET.

At the area surveyed in INTEC, the EMR provided numerous indications of buried piping. However, this area was extremely cluttered with many different buried utility systems and processing pipes. Currently, the data are being evaluated and interpreted to provide a map identifying the buried items along the survey path.

At this time, initial indications of the EMR are that this technology best fits identifying and locating soil contaminants. This technology can cover 100% of the soil area to ensure or assist with the characterization and documentation needed for making D&D decisions. The EMR appears to be more cost effective by reducing the number of samples needed to characterize a contaminant plume. In addition to the tremendous cost reduction, the EMR provides:

- Reduction in worker exposures
- Potential increase in the quality of the characterization data
- Reduction in the amount of waste generated by the sample collection methodology
- Reduction in the amount of personal protective equipment used by the field personnel.

ACKNOWLEDGMENTS

Work supported by the U.S. Department of Energy, Assistant Secretary for Environmental Management, under DOE Idaho Operations Office Contract DE-AC07-99ID13727.

We would like to express our sincere gratitude to all those involved with the INEEL LSDDP demonstrations.

REFERENCES

August 1986, “Development of Criteria for Release of Idaho National Engineering Laboratory Sites Following Decontamination and Decommissioning,” EG&G Idaho, Inc., Internal Document Number: EGG-2400.

February 1998, “Chicago Pile 5 (CP-5) Research Reactor Large Scale Demonstration Project, Innovative Technology Summary Report”, Office of Science and Technology (OST)/Argonne National Laboratory-East, (OST Reference Number 2098).