EM International Programs

HOUDINI™

STRATASAMPLER™

GAMMACAM™

U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

The Environmental Management (EM) International Programs' goal is to pursue international collaboration among government organizations, educational institutions, and private industry to identify technologies that can address U.S. environmental problems, particularly EM cleanup needs. International Programs also works to identify international environmental problems and establish mechanisms by which U.S. government environmental restoration/waste management technologies will be transferred to the U.S. private sector for commercialization and possible transfer to international markets.

Three technologies that have been deployed overseas are:

- STRATASAMPLER™ in Russia
- GAMMACAM™ in Estonia
- HOUDINI™ in United Kingdom

RUSSIA

Problem:

The Department of Energy (DOE) is responsible for the remediation and disposition of more than 3,700 contaminated sites, 1.5 million barrels of stored waste, 385,000 cubic meters (m^3) of high-level waste in tanks, and nearly 7,000 facilities. The development of new characterization and monitoring technologies that are better, faster, cheaper, and safer than existing technologies will significantly reduce the overall cost in the environmental cleanup process.

On a much larger scale, the Ministry of Atomic Energy for the Russian Federation (MINATOM) is faced with the characterization of the world's largest amounts of surface and subsurface radioactive contaminants, located primarily in the West Siberian Basin. Within this area is Lake Karachay, which was used by the Mayak Production Association as an unlined surface repository of liquid radioactive wastes from former nuclear production and separations activities. It has a groundwater contamination problem that resides within a fractured rock hydrogeological setting similar to those found at the Idaho and Oak Ridge sites.

U.S. and Russian Scientists install a StrataSampler™ in the Mishelyak River Valley

Solution:

The Characterization, Monitoring, and Sensor Technology Crosscutting Program (CMST-CP) addresses DOE's needs to develop and implement innovative technologies. This coordination activity, which supports the Office of Environmental Management's Office of Science and Technology, Waste Management, Environmental Restoration, and Facility Transition and Management, addresses the following technology needs: a) initial location and characterization of wastes and waste sites before treatment; b) monitoring of waste retrieval and remediation processes; c) characterization and monitoring of waste treatment processes, products, and effluents; and d) site closure and long-term compliance monitoring.

Technology Identified – StrataSampler™:

Under the auspices of the Site Characterization and Contaminant Transport Area of the Joint Coordinating Committee for Environmental Restoration and Waste Management (JCCEM), MINATOM and DOE are collaborating on a multi-year international cooperative project to characterize and model the fate and transport of contaminated groundwater systems. The purpose of this initiative is to solve common Russian and American environmental management problems through joint studies that include exchanges and collaborative development of instrumentation, analytical methods, historical data, computer modeling, and other activities.

A U.S. scientist collects water samples from a StrataSampler™ in the Mishelyak River Valley

In July 1997, the third Chelybinsk Field Study was conducted to investigate contaminated groundwater migration from Lake Karachay in the Mishelyak River Valley in Russia. Since the contaminated groundwater is a relatively dense brine and flows in both porous sediments and the fractured rocks underlying them, field measurements are necessary to characterize the three-dimensional flow and contaminant-migration characteristics for model development. To collect representative water samples from targeted geological layers, the collaborative Russian and American field team used a special well-sampling device known as the StrataSampler™, which was developed under CMST-CP sponsorship. The samplers deployed in Russia were modified using a docking assembly designed by MINATOM's Hydrospetzgeologia to adapt the samplers to Russian pipe and thread. The StrataSampler™ has also been deployed three times at the Savannah River Site.

Enhanced by the use of the StrataSampler™, the successful field study yielded new and important data to be used in ongoing modeling work. These data, along with analyses from collected soil cores, help to understand hydrogeological parameters and sediment properties not only within the discharge area of Mishelyak River but are also applicable to validating and verifying contaminant migration models used in the United States.

Benefits:

- Simple, yet robust design does not require special installation methods
- Collects discrete samples from different depths in a single borehole, thus minimizing drilling costs
- Isolated sample intervals do not require secondary isolation using packers, which also reduces the potential for vertical migration of contaminants in the monitoring well
- Approximately 50% less expensive than existing methods

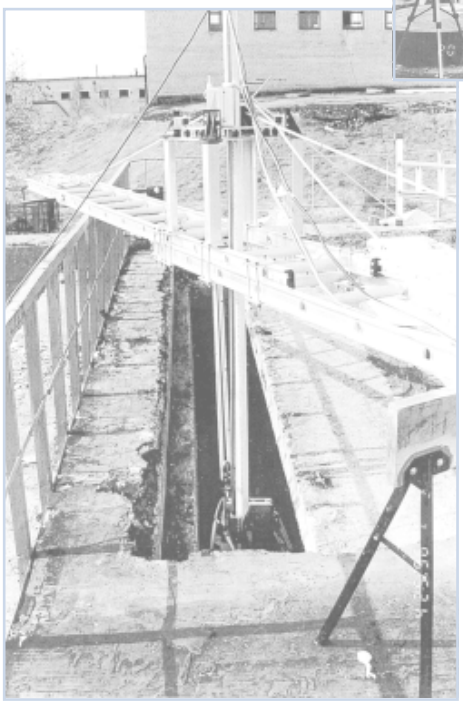
ESTONIA

Problem:

The Deactivation and Decommissioning Focus Area (DDFA) is responsible for developing technologies to solve DOE's challenge of deactivating and decommissioning 7,000 contaminated buildings.

A similar problem was being faced by the Estonian government, who recently acquired the former Soviet Union Naval Nuclear Submarine Training Facility, which is located in Paldiski, Estonia. In 1995, the Soviets turned this facility over to the Estonian Government, who became responsible for its decontamination and decommissioning. The facility contained two nuclear reactors that were shut down in 1989 for safety reasons. Building 307 was the site's above ground solid waste storage facility that consisted of 10 separate storage cells. Of main concern to the Estonian government was the contents of Cells 1 and 5, which displayed the most significant radiological fields. Records from the former managers of the facility were incomplete, and there was significant uncertainty as to what was contained in these storage cells and how contaminated it would be.

GammaCam™ ready to be lowered into Cell 5



This photo shows the Manipulator over the Slab 1 opening of Cell 1 of Building 307 with the sensor head located just below the roof level

Solution:

The DDFA is addressing these problems by developing, demonstrating, and deploying technologies that generate lower quantities of waste materials, are lower in cost, require less labor, reduce exposure of personnel to radioactive and other hazardous materials, and improve worker safety. Innovative and improved technologies are being developed for characterization of contamination, decontamination of buildings and materials, dismantlement of buildings and equipment systems, reuse or recycle of materials, waste minimization, and worker protection and safety.

Technology Identified – GammaCam™:

System tripod mounted with computer controller visible in van

The GammaCam™ was selected by the DDFA for demonstration in the large-scale demonstration project at the Chicago Pile 5 (CP-5) research reactor at Argonne National Laboratory. This system displays the relative strength and location of gamma radiation as a two-dimensional image superimposed on the corresponding visual image. The GammaCam™ consists of a portable sensor head that contains a gamma-ray imaging system and a TV camera. The superimposed radiation and visual images are displayed on a standard portable computer (PC) screen located several hundred feet from the radiation area. The PC controls the data acquisition time, field of view, and image display. The system was demonstrated successfully at the CP-5 research reactor for imaging radiological spills, isolating radiation sources located inside a concrete vault, and detecting and eliminating areas of radiation leakage in temporary shielding.

In 1996, participating as a member of the Paldiski International Expert Reference Group expedition, DOE performed a preliminary site characterization of the former Soviet Union's Naval Nuclear Submarine Training Facility, which included both aerial and ground radiological surveys. The GammaCam™ system was used to record gamma-ray images of several of the ground areas in and around the training facility. During the expedition, the GammaCam™ efficiently localized the key radiological contributors in waste storage cells. With minimal operator exposure, the system operated in a very high radiation area, greater than 70R/hr, and produced images that will be used in the planned site remediation. The location of the radiation sources was verified by Swedish members of the expedition through use of a gamma spectrometer. It has been recommended that once these higher radioactive materials are removed, a second image should be taken to determine the presence or absence of any lower level contributors.

The GammaCam™ has also been deployed a total of six times at four DOE sites (Idaho National Engineering and Environmental Laboratory, Argonne National Laboratory, Los Alamos National Laboratory, and Hanford).

Benefits:

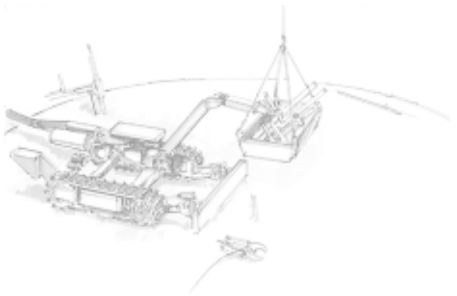
- Remote operation and control allows safe image acquisition in high radiation environments, minimizing operator exposure
- Provides users with the precise locations of radiological sources in an easy to use format
- Its small footprint and light weight allows for easy setup and portability essential for efficient cost effective usage

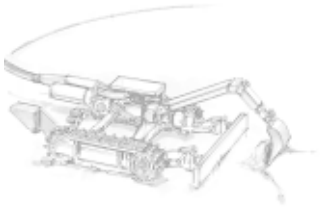
UNITED KINGDOM

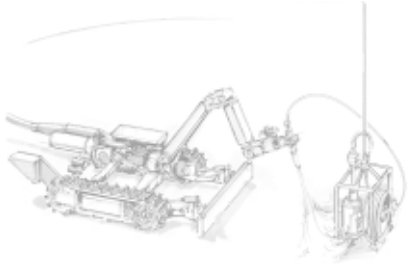
Problem:

The retrieval of radioactive, chemical, and other wastes stored in the DOE above and underground waste storage tanks is a hazardous and geometrically challenging task that defies strictly manual methods or existing remote technology. The use of remote equipment has been identified as the necessary mode of tank waste removal. Mobile worksystems are attractive for in-tank operations because they provide flexible tool deployment platforms. However, existing mobile worksystems with sufficient work capability are too large to be deployed through existing tank openings.

A similar problem is being faced by the British Nuclear Fuels Ltd. (BNFL) in the United Kingdom (UK). BNFL engineers are responsible for the development of reliable waste retrieval technologies that can be used to retrieve waste from the six B241 tanks located at their Sellafield plant. These tanks, which have been used to store alumino-ferric flocs produced as a by-product of nuclear fuel reprocessing, contain a total of 7,400 m^3 of sludge and supernate. In support of the planned decommissioning of these tanks, all of the sludge material as well as two-inch piping and a concrete wall must be removed from the bottom of the tank. The tanks are approximately 15 meters in diameter and 10 meters in height.







Solution:

The Tanks Focus Area (TFA) is addressing these problems by developing, demonstrating, and implementing technologies that generate lower quantities of waste materials, are lower in cost, require less labor, reduce exposure of personnel to radioactive and other hazardous materials, and improve worker safety. Innovative technologies are being developed for characterization of contamination, decontamination of buildings and materials, dismantlement of buildings and equipment systems, reuse or recycle of materials, waste minimization, and worker protection and safety.

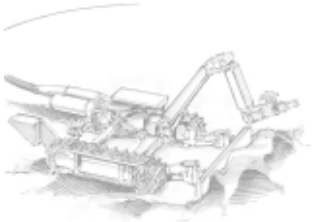
Technology Identified – Houdini™:

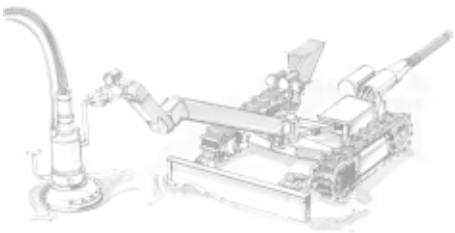
Developed in support of the TFA activities at Fernald in conjunction with the EM Industry Program and the Robotics Crosscutting Technology Development Program, the Houdini™ system is a reconfigurable in-tank mobile robot that is designed to eliminate or reduce potential public and operational health risks associated with work on DOE underground storage tanks. The Houdini™ robot carries a plow, robotic arm, and camera to the tank bottom for sludge retrieval operations.

Based on the successful demonstration of the Houdini™ system in the underground gunite storage tanks at Oak Ridge National Laboratory, BNFL wanted to observe the operation of the system at its mockup tank facility located at its Capenhurst site in Chester, UK. This technology was successfully demonstrated in April 1998, at Capenhurst, resulting in a collaboration between United States and BNFL representatives. Discussions regarding the modifications necessary for optimizing the Houdini™ design for the unique conditions that exist in the B241 tanks are currently underway.

In addition, Houdini™ has been deployed four times at Oak Ridge National Laboratory.

Video monitoring of the Houdini™ robot activity





Benefits:

- Folds up to enter through a 24-inch riser
- Tracks enable maneuverability in sludge
- Equipment can be customized for use in unique and challenging radioactive and chemical environments

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