PORTABLE URANIUM SURVEY TOOL USING LASER-INDUCED FLUORESCENCE IMAGING

TECHNOLOGY NEED

Several areas and facilities on DOE sites have the need for rapid, real-time survey technologies that can determine the presence of surface contamination and distinguish selected elements, such as uranium, from significant background radiation levels. For example, rapid, real-time survey sensors are needed to efficiently survey areas and facilities like the UF_6 cylinder storage yards and the pipes and equipment in the K-25 buildings at Oak Ridge National Laboratory (ORNL). Several DOE sites have scrap metal parts that they would like to screen for release. In the case of scrap metal, uranium may be present in a thin film at low activity levels (less than one-thousand disintegrations per minute), making it impractical to survey by conventional techniques. The portable Laser-Induced Fluorescence Imaging (LIFI) sensor system can quickly identify low levels of uranium oxides on surfaces even when there is a significant radiation background that tends to mask its presence using conventional detection techniques. The baseline techniques are the use of Geiger Mueller "Pan Cake Friskers" and chemical swipes. Field radiation detection instrumentation is commercially available, but these technologies are not as cost effective for most large area applications as LIFI.

A related future development is the engineering of tailored chemical materials that cause non-fluorescent materials to become fluorescent and, therefore, made detectable by LIFI. Chelates and sequestering agents are used to cause a fluorescent indication of contamination on surfaces. More importantly, these agents can be used to detect small leaks in waste transfer pipelines and similar situations where high background radiation levels mask the presence of uranium.

The following are some of the needs identified by Site Technology Coordination Groups that are addressed by the portable LIFI uranium detector:

- OH-F012 - Improved facility survey techniques.
- RL-DD05 - Characterization of Building 324.
- RL-DD07 - Fixatives for Building 324.
- RL-DD014 - Fixative for K-Basins.
- RL-DD017 - Characterization technologies for segregating contaminated versus non-contaminated as well as transuranic versus non-transuranic materials for disposal.
- SR-4002 - Characterization of contaminated surfaces.
- RF-DD02-98 - Characterization of contaminated surfaces (low-level versus free release)
- RF-DD01 - Characterization of contaminated surfaces (transuranic versus low-level).
- AL-07-01-12-DD - New technologies to decontaminate and decommission radioactively contaminated facilities.
- NV10-9801-10 - Improved detection and characterization of radioactive contamination on large concrete and metal surfaces.

TECHNOLOGY DESCRIPTION

Laser-induced fluorescence uses light to stimulate optical emission in materials. Unique spectral signatures allow for the discrimination of contaminants from background materials. The data are displayed as a real-time image . The portable system will provide real-time analysis permitting timely decisions to be made at the survey site.

BENEFITS

- Fluorescence techniques have the ability to detect and recognize spectral signatures that are not observable by conventional or baseline methods.

- The high spatial resolution of intensified charge coupled device (CCD) cameras and the time-resolved phosphorescence emission characteristic of the uranyl ion allow a picture to be created that shows the extent of surface uranium contamination. This visual image allows mitigation efforts to be focused on specific areas and that speeds the survey and lowers overall costs.
- The real-time image processing of the data into a false color composite on a gray scale background allows the operator to quickly distinguish the uranium signature. Since the data are recorded as digital TIFF files, it can be reviewed for planning and review of deactivation and decontamination activities.

CAPABILITIES/LIMITATIONS

In areas where there is a potential health risk, such as often is found during some deactivation and decommissioning operations, the health physicist can stand many meters away from data acquisition. This has been demonstrated at both the Fernald Site in Ohio and at the K-25 Site in Oak Ridge, Tennessee. The standoff also allows quick surveys of overhead areas not accessible without ladders. More traditional radiation tools such as gamma and beta meters can then be used, if necessary, at identified hot spots to quantify the levels present. Current project activities now include the investigation of LIFI capability to free release material such as rails.

In areas of high background radiation, the LIFI technique detects the exterior contamination with no signal interference from the radioactive material in the container. This detection was demonstrated at the UF6 cylinder storage yard (E yard) at the K-25 Oak Ridge Gaseous Diffusion Plant. By expanding the monitoring and characterization to include the enabling technologies (chelating agents that activate fluorescence), seals and connection flanges can be monitored rapidly for leaks. LIFI detects the leaks as chemical signatures that are unaffected by the high radiation backgrounds.

LIFI, however, is limited to detecting uranyl oxides, the dominant contamination at processing sites. The uranium [U(VI)] oxide is fluorescent while the other oxidation states are only weakly observed or dark. Fortunately, the U(VI) dominates many stages of the production process. The other oxides will be detectable through the use of the tailored chemical material enabling technologies described on the previous page.

COLLABORATION/TECHNOLOGY TRANSFER

Technology transfer is currently envisioned to include continued participation with the EM-partners at Oak Ridge (K-25) resulting in the eventual replication of the deactivation and decommissioning tool. If commercialization is deemed appropriate and economically rewarding, a commercial partner will produce the units. If several units are required for immediate deployment, several more would be produced in-house for DOE use. In addition to uranium clean up, other applications will benefit from the real-time fluorescence survey capability. New users, both in and outside the DOE, have been identified DOE (petroleum leaks), law enforcement (forensic applications), and vegetation monitoring (agriculture). During FY 1998, additional uses will be explored and potential commercial partners will be identified. The identification of a large user base will be used to determine the extent of potential commercial viability.

ACCOMPLISHMENTS

The LIFI technology has been demonstrated at a variety of DOE sites. The original system used to make the first LIFI measurements weighed 1,500 pounds. The intermediate system weighs 150 pounds including the batteries. In its final configuration, the survey tool will weigh about 39 pounds and can be carried like a backpack. It has been designed to be easily replicated from original equipment manufacturer (OEM) components. The system is easy to use and has a simple user interface that stores digital imagery (TIFF) that can be imported in word processing packages.

TECHNICAL TASK PLAN (TTP) INFORMATION

TTP No. NV05C253 Title - Portable Laser-Induced Fluorescence Imaging System

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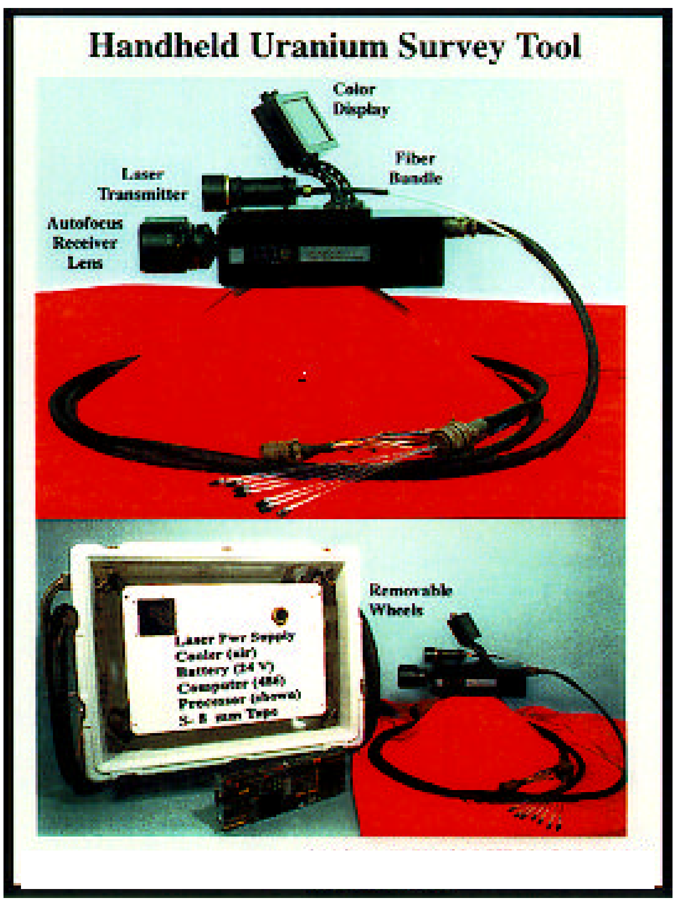

These are the components of a portable Laser-Induced Fluorescence Imaging (LIFI) and filtering technique for real-time uranium detection.