ADVANCEMENTS IN REMOTE CHARACTERIZATION OF CONTAMINATED SURFACES

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ABSTRACT

The legacy of Cold-War nuclear-weapons materials production now presents an increasingly urgent problem for achieving safe and effective remediation. The United States, Russia, (and other countries to a lesser extent) are faced with remediating sites containing large amounts of radioactive and chemically active materials, sometimes stored under inadequate conditions. Many of these materials are liquid and solid wastes of mixed or unknown composition, stored in tanks that may be leaking. Additionally, many facilities and equipment must be decontaminated to restore sites to acceptable states for public acceptance.

As part of a joint US – Russian endeavor involving several US and Russian entities and US companies, several new techniques have been developed for waste-tank remediation, characterization of contaminations, facilities and equipment decontamination, and immobilization or volume-reduction of wastes.

Effective decontamination of facilities (such as tanks or building walls and floors) and equipment benefits from characterization of the contaminants. The US – Russian partnership has developed the Gamma Locating Device™ (GLD) for remote characterization of contaminated surfaces using the residual gamma activity on various surfaces. The technology can significantly reduce the need for sampling to determine the residual gamma activity in a contaminated facility. The GLD combines a gamma spectrometer with a video imaging system and rangefinder to provide a graphic image of the extent and location of contamination. The GLD detects gamma emissions using a collimated detector that is capable of measuring specific nuclides in a high-background environment. The gamma spectrum is captured with a multichannel analyzer, and the spectra of ^{241}AM, ^{137}Cs, and ^{60}Co are analyzed for their intensities. The system is responsive to these nuclides in the range 0.5 mCi to 1 Ci. The device is tetherless and can survey large areas from a single location, with an azimuth range of ±160° and an elevation range of +90 – -25°.

The GLD has been successfully deployed at both US and Russian sites. It has applications for decontamination campaigns at nuclear sites such as reactors and other processing facilities, for evaluating accidental contaminations, and for final activity measurements at sites that have been decontaminated.

INTRODUCTION

A necessary step in mitigating and remediating radioactive contaminations is the characterization of the contaminated surfaces and objects. The first application of the Gamma Locating Device was a robot-vehicle-mounted campaign to identify the parts of the Chornobyl reactor Number 4 from among the other debris at the accident site. This application utilized a Russian-made tetherless remotely controlled vehicle with a gross-gamma detector, radiation-hardened video camera, and a laser rangefinder. Subsequently, the gamma-detection capability has been enhanced by incorporating a multichannel analyzer to permit the identification of specific nuclides. Currently, through a Russian–American partnership, this method of non-contact characterization of radionuclide emissions has been further enhanced and commercialized. The Gamma Locating Device[1] (GLD) provides a method for measuring and characterizing residual gamma-ray activity on various surfaces.

DESCRIPTION

The GLD detects gamma-emitting nuclides using a collimated detector. The system was designed to measure emissions from specific nuclides in high-background-radiation environments. A built-in rangefinder determines the distance to the source being measured so that source intensities can be determined. The GLD detector is positioned in the area to be measured, remotely from the control and analysis equipment, and communication for control and data are transmitted by wireless means. The system uses a multichannel analyzer to capture and identify radionuclides. Spectral lines of target isotopes are stored in the MCA and compared against the data. The system includes a television camera to provide visual images, and a graphic representation of the radiation intensity distribution is superimposed on the visual image (Fig. 1). The combination of visual image, isotopic radiation intensity, and distance to source (and thus areal extent) may eliminate the need for sampling of the contamination. Table I provides the operational characteristics of the Gamma Locating Device.

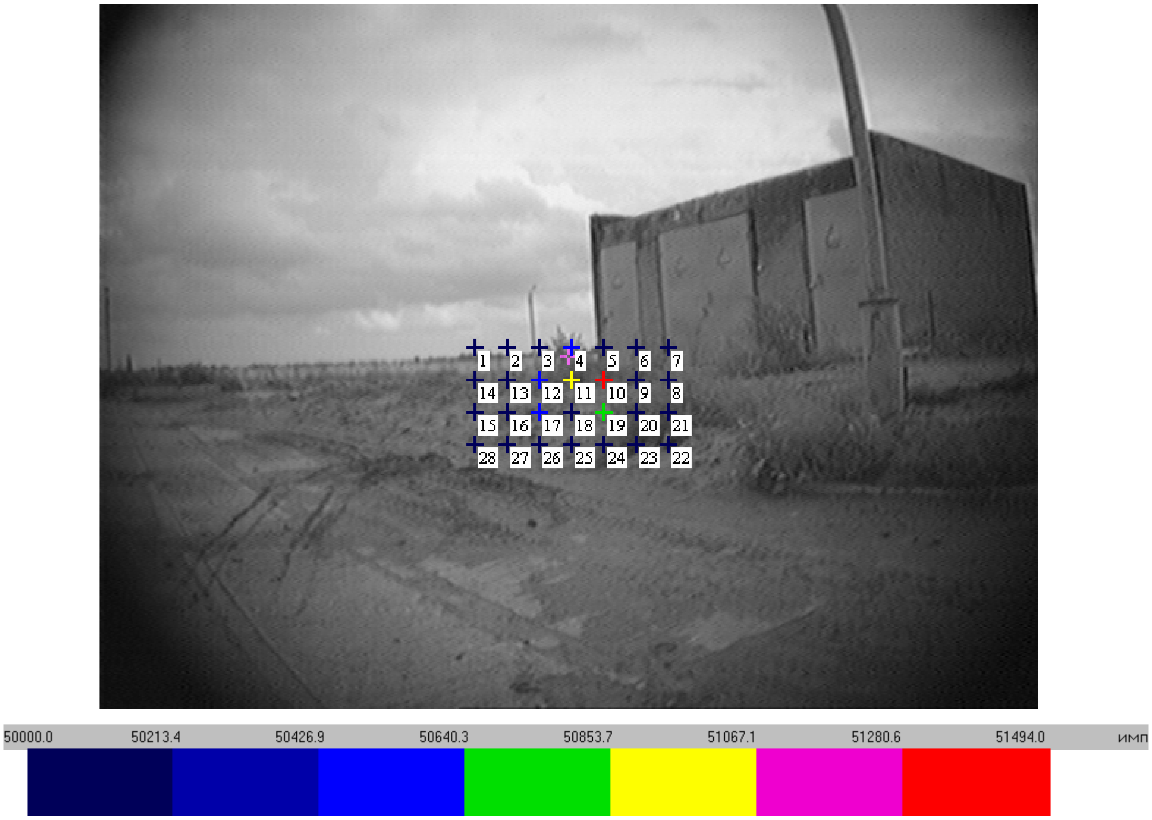

Fig. 1 Illustration of combination of visual and radiation-intensity map

Table I GLD design characteristics

Isotopes identified (standard configuration)	Am-241; Cs-137; Co-60
Gamma energy detectability range	0.03 — 1.2 MeV
Source intensity range at 1 m	0.5 mCi — 1.0 Ci
Radiation rate range of isotropic detector	10^{-2} — 100 R/hr
Maximum radiation rate for spectrum measurements	< 10 R/ hr
Distance range between measured surface and detector	0.5 — 100 m
Horizontal scanning angle	±160°
Vertical scanning angle	+ 90°— -25
Maximum distance for radio control	500 m
Maximum distance for receiving TV images	200 m
Operating temperature range	–10° —+40°C
Operating voltage	12 V
Power consumption	< 40 W
MCA resolution	1024 channels

APPLICATIONS

Typical applications are surveys of environmental radiation contamination prior to decontamination activities. A test of the GLD by INEEL demonstrated that the system was able to provide contamination levels within a matter of minutes, with almost no radiation exposure to personnel, in contrast to baseline operational practices of:

- radiation survey teams,
- (2) video crews,
- (3) hand collection of samples, and
- (4) laboratory measurements of radiation levels, requiring many weeks.

When mounted on a remotely operated vehicle the GLD can characterize radiation contamination in inaccessible areas. The absence of control cables reduces the problems of maneuvering the device in congested areas. The Russian design team has developed alternative applications for the GLD. When mounted on waste-tank retrieval equipment, the GLD can survey the entire interior of a tank from a single location (Fig. 2). The combination of a video image with the superimposed radiation intensities can accurately locate areas in tanks (such as "bathtub rings") where additional decontamination is required to meet closure standards. Lastly, the GLD has applications for characterizing radiation emissions from unknown objects or from off-normal releases. The combination of a GLD with remotely controlled bomb-detection and disposal equipment could reduce the uncertainty regarding the existence of radiation-dispersal devices.

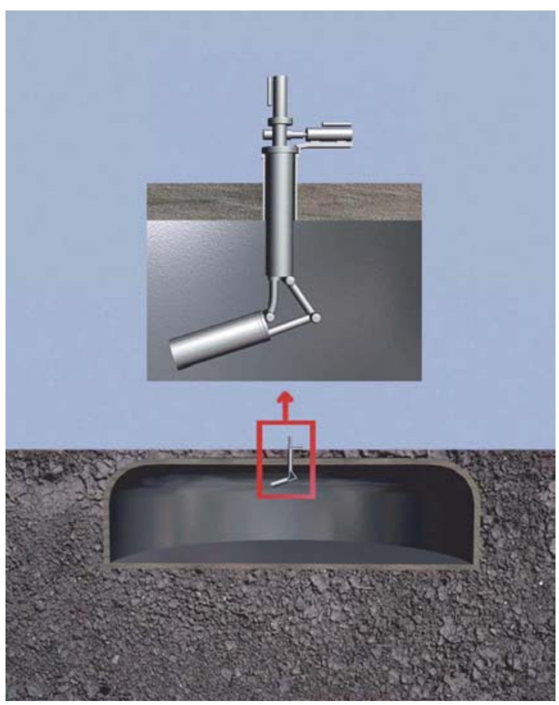

Fig. 2 Illustration of application for characterizing interior of a waste tank

SUMMARY

The Gamma Locating Device has proven itself at Chornobyl and INEEL as a system that can accelerate and simplify evaluations of radioactive contaminations, with significantly reduced personnel radiation exposure. New applications for waste-tank closure and emergency response greatly expand its possible uses. The poster presented at the Waste Management Conference is shown in the following Fig. 3.

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[1] Russian patent pending, and US patent protection being sought