LA-UR-95- 175

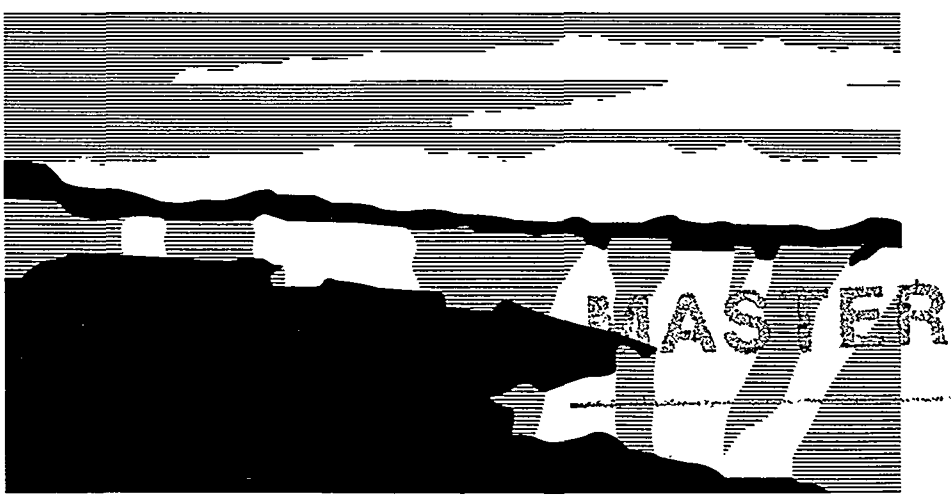
Conf-950216--113

Title: **Alpha Characterization of Concrete Surfaces at Decontamination & Decommissioning (D&D) Sites**

Author(s): T. Q. Vu
M. W. Rawool-Sullivan
J. Koster
D. Stout
A. Beasinger

Submitted to: Waste Management '95 Conference
Tucson, AZ
February 27 - March 3, 1995






**Los Alamos**
NATIONAL LABORATORY

## DISCLAIMER

# Alpha Characterization of Concrete-Surfaces at D&D Sites

T.Q. Vu, M.W. Rawool-Sullivan, J. Koster, D. Stout, and A Beasinger
Los Alamos National Laboratory

## ABSTRACT

Waste minimization and worker protection at D&D sites requires continual and extensive characterization for radioactive contamination. Contamination detectors that are sensitive, rugged, fast, and capable of covering large areas are needed. The concrete surface monitor (CSM) developed at Los Alamos National Laboratory (LANL) supports both characterization and waste minimization efforts at D&D sites containing large concrete surfaces and structures of different forms and shapes. This report describes the CSM design and the results of several field experiments.

## INTRODUCTION

Typical radioactive contaminants consist of uranium or plutonium. These isotopes emit alpha particles. An alpha particle can travel approximately 4 cm through air; with such a short range, traditional direct detection methods are often ineffective. Instead of detecting the alpha particle directly, the CSM detects the ion pairs created as alpha particles interact with air molecules. As a 5 MeV alpha particles interacts with air molecules, it will generate on average of 150,000 ion pairs, resulting from the 35 eV energy loss for every ion pair production (1). An electrostatic field in the CSM transports these ion pairs to a detection plate. The ion pairs generate a small current proportional to the alpha source strength that is detected by an electrometer. As compared to traditional detectors, the CSM can operate effectively at much higher level of sensitivity while allowing real-time, and *in-situ* operation.

Using the 300 $cm^2$ CSM, large concrete surfaces can be characterized effectively. An active detection surface ranging from 300 $cm^2$ to 2500 $cm^2$ allows CSMs to monitor over a larger surface area with a single measurement. By characterizing concrete surfaces before, during and after D&D work, the amount of radioactive waste could be minimized. The use of the CSM to support waste minimization will effectively cut the cost of D&D expenditure.

## CSM DESIGN

The concrete surface monitor is based on the electrostatic Long-Range Alpha Detector (LRAD)(2). The current generated by the CSM is detected by the sensitive electrometer developed by Guy Arnone at LANL specifically for LRAD detectors. The reading can either be sent to a portable computer or read out directly on a portable oscilloscope for a visual intepretation. There are two types of surface monitors; the 2500 $cm^2$ includes background subtraction technology while the 300 $cm^2$ , and 1431 $cm^2$ CSMs do not. A more detailed description of the LRAD Surface Monitors has already been described in several reports for soil surfaces application (3,4).

The CSM was built specifically for field demonstrations and characterization of concrete block edges at a D&D site at Los Alamos National Laboratory. Due to the size of concrete block surface area, a CSM was designed with an active volume of 27 cm X 11 cm X 10 cm aluminum box with an opening on the bottom, yielding a 300 $cm^2$ detection surface. An adjustable clamp was used to fasten this monitor to the block creating a firm contact between instrument and detection surface with varying degrees of freedom.

A background subtracting surface monitor is shown schematically in Figure 1. In this detector the alpha particles emitted from the concrete surface create ions only in the lower chamber, and hence a signal only from the first signal plate. All of the ions created by surface contamination will be transported to the lower signal plane; none pass into the upper chamber. Radioactive radon gas which enters the lower chamber from the concrete surface is not electrically charged, so that it can freely pass into the upper chamber. This gas will decay equally in both chambers, resulting in an identical contribution of signals on both the first and second signal plates. To speed up the mixing of radioactive gas into both chambers, a small fan is inserted between the chambers [5].

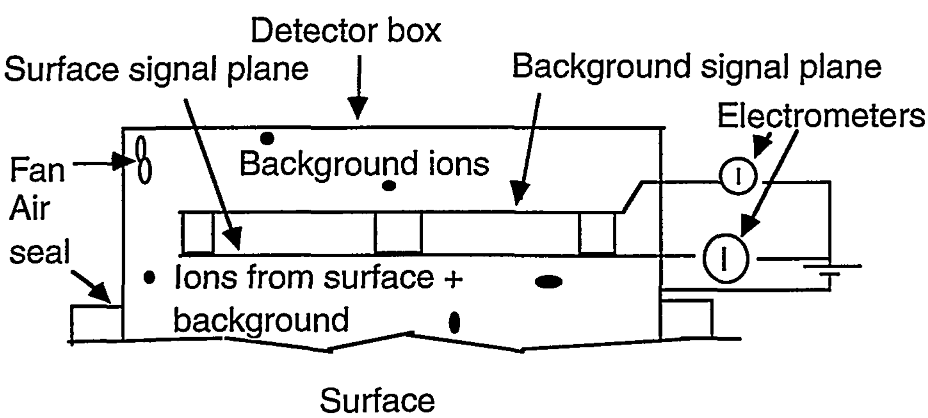



Fig. 1. Schematics of background subtracting CSM.

A CSM with an active volume of 50 cm X 50 cm X 10 cm, and a 2500 $cm^2$ detection surface, allows measurements over larger surfaces with a single reading. Again, the response time for both CSMs is between 30 and 120 seconds per reading depending on the strength of the contamination.

In the final analysis the current was measured from the top chamber (instrumental background at that level) and subtracted from the current measured from bottom chamber (signal from floor plus instrumental background at that location). The background subtraction CSM calibration factor was measured at 6 dpm/fA. Two instrumental background readings were taken on the aluminum plate. The results of the instrumental background readings are in table 1, showing both the upper and lower chamber activity.

Table 1. Instrumental background reading from the background subtraction CSM

| Background Readings No. | Lower Chamber [fA] | Upper Chamber [fA] |
|---|---|---|
| 1 | 184 ±8 | 179 ±9 |
| 2 | 122 ±11 | 121 ±12 |

This data for both the upper and lower chamber shows essentially the same reading.

FIELD DEMONSTRATIONS

Concrete Block Measurements

On July 15, 1994, the first generation CSM was used to measure the residual alpha contamination on concrete blocks which came out of trenches at Technical Area-21 (TA-21) at LANL. The dismantling of trenches is a part of the D&D effort currently in progress(6).

The 300 $cm^2$ CSM's were used due to their appropriate size and attachment clamps. Prior to demonstration, the detectors were calibrated using a set of NIST traceable Pu-239 sources ranging from 100-5620 dpm. The sensitivity of the 300 $cm^2$ CSM is 7.1 dpm/fA. The sensitivity of other CSMs ranges from 5.5 to 7.1 dpm/fA.

The concrete blocks to be monitored were cut out of trenches. The surface to be monitored was relatively flat, although some area were rather rough and irregular. These blocks were placed with varying angles, hence at some locations a clamp attachment was used to secure the detector and create an air seal between the surface and detector volume. For background measuremens, an aluminum (Al) plate was used. The Al plate underneath the detector prevents penetration of any alpha radiation from the concrete or ground into the detector. This gives an instrumental background measurement from leakage current, electronic noise, and leakage of outside air into the monitor and the ambient level of gamma radiation but does not measure any alpha emissions from the surface.

A total of 10 readings were taken from various locations on three different concrete blocks. For each point the instrumental background were subtracted from the measured reading giving the actual surface activity. For comparison purposes, readings from concrete surfaces around the town of Los Alamos were taken from 9 different locations. These locations include an apartment complex, a sidewalk of businesses, historical landmark, aquatic center, church, library, and the local post office totaling 27 readings. In Table 2 the results from both experiments are compared.

Table 2. Results from field experiment on contaminated concrete blocks at TA-21 D&D site, and the city Los Alamos sites.

| TA-21 D&D CONCRETE BLOCKS RESULTS | | |
|---|---|---|
| Block ID | Sample No. | Readings dpm/100 $cm^2$ |
| 1 | 1 | 854 |
| | 2 | 467 |
| | 3 | 467 |
| 2 | 1 | 777 |
| | 2 | 933 |
| | 3 | 621 |
| 3 | 1 | 621 |
| | 2 | 700 |
| | 3 | 700 |
| | 4 | 210 |
| For comparison, readings within the City of Los Alamos ranges from 62 to 93 dpm/100 $cm^2$ above background due to the natural activity in concrete. The measurement were taken from apartment complexes, side-walk of businesses, historic landmark, aquatic center, church, library, and the local post office. | | |

A potential error of ± 20 dpm/100 $cm^2$ was determined to be a direct result from using the portable oscilloscope and the concrete. Concrete has an intrinsic activity level (even when concrete is 'uncontaminated') and these readings may be showing variations in the 'natural' activity of the concrete..

Water Tower

On May 31, 1994, the 1431 $cm^2$ CSM was used to characterize 18 $m^2$ area under a water tower at TA-21. A total of 24 points were taken at 50 cm interval. Instrumental background was again taken on an aluminum plate. Relative to this background, the highest observed points were 160 dpm/100 $cm^2$. This area is relatively clean based on the Department of Energy public release limit of 300 dpm/100 $cm^2$ for transuranics. Figure 2 shows the water tower at TA-21 prior to demolition and removal to dump site.

Fig. 2. The water tower at TA-21; the area under this tower was characterized.

Most of the readings were between 40 and 80 dpm/100 $cm^2$ above the instrumental background. Figure 3 shows the contour plot covering the accessible. The result yield a maximum count of 160 dpm/$cm^2$. This area is relatively clean and independent measurements performed by the site health physicist with a commercialized detector which confirmed our evaluation.

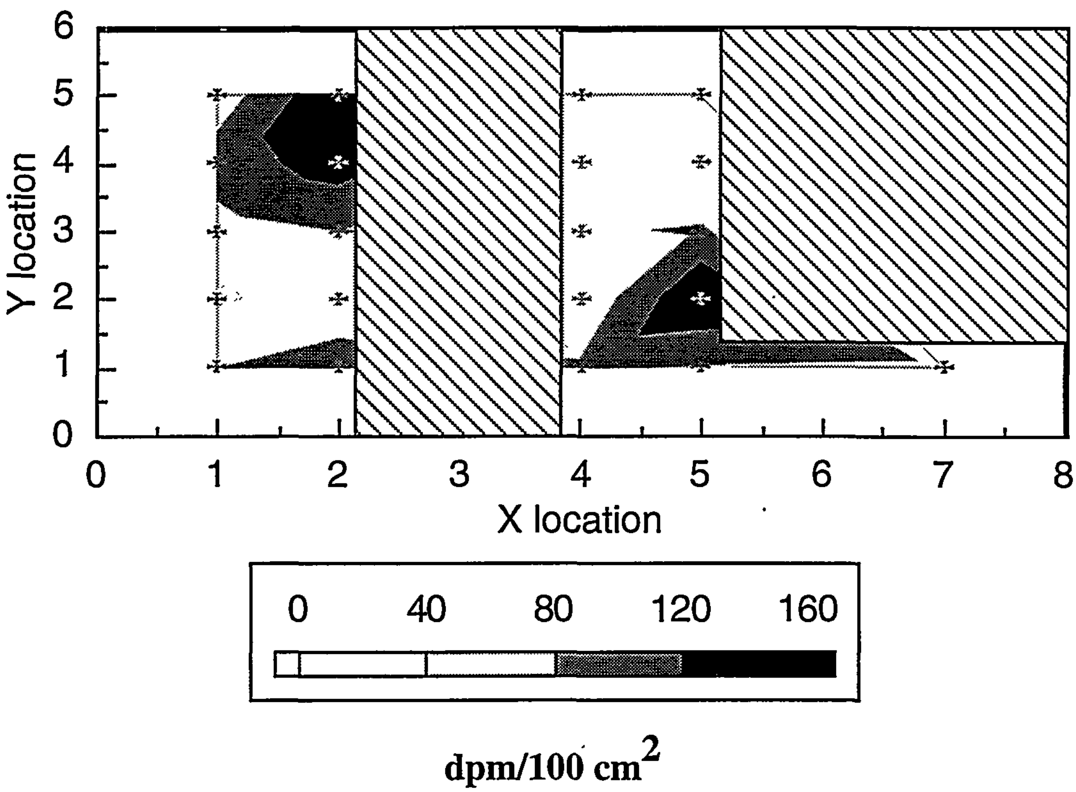



Fig. 3. A contour plot of the measured activity level under the water tower.

Previous measurement using similar LRAD soil surface monitors found a naturally occurring alpha emission background around 200 dpm/$cm^2$, therefore most of these readings above instrumental background can be ascribed to naturally occurring activity.

Utility Pads and Concrete Floors

On August 30, 1994, both the background subtracting, and 1431 $cm^2$ hand held CSM were used to measure the residual alpha contamination on the floors of building 146, and surrounding concrete pads of TA-21 site. Depending on the size of the area to be monitored, appropriate CSMs were used. The background subtraction CSM was used on the floor in building 146 since it has the larger detection area. The utility pad and water tower outside building 146 was sampled with the hand held CSM. Instrumental background was checked using the aluminum plate at a regular interval. The collected ions were read out using the LANL electrometer and a portable oscilloscope. Figure 4 shows the 24 readings taken from the concrete floor. Some regions were inaccessible as shown by the single-hatched marks.

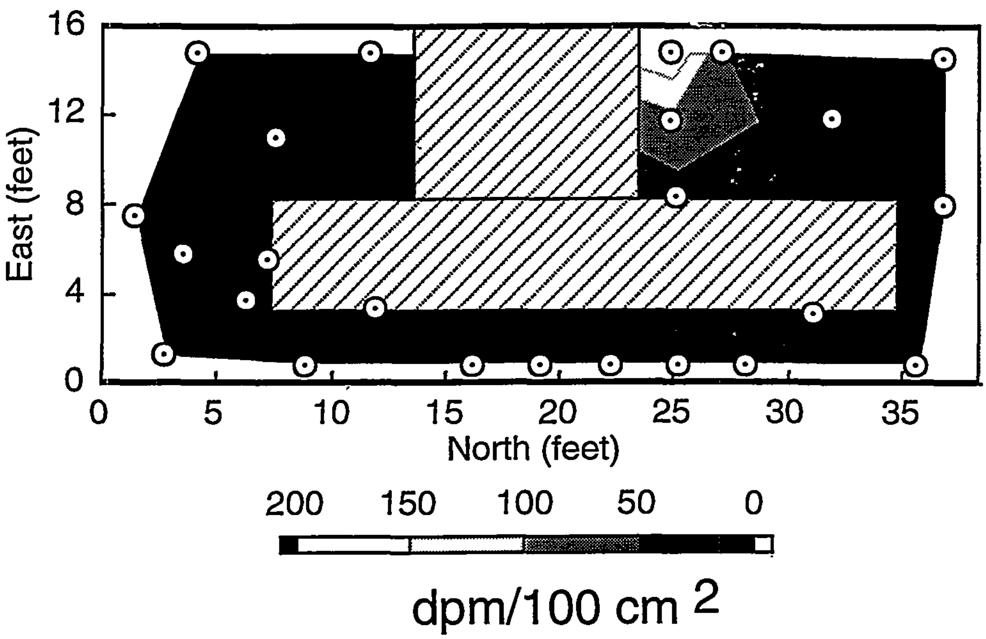



Fig. 4. A contour plot of alpha activity on the concrete floor at TA-21 (building 146) D&D site.

We took a total of 42 readings on a 61 cm grid on the utility pad. The measured activity varied from 0-40 dpm/100 $cm^2$ above instrumental background for most readings. The concrete floor was measured using the background subtracting CSM. With an active detection surface area of 2500 $cm^2$, it covered more area with each measurement. Generally the activity ranges from 0-50 dpm/100 $cm^2$. Three of the 24 readings show higher levels of alpha activity. One reading shows 193 ±5 dpm/100 $cm^2$; visually this location shows a fairly large grease spot. Two other locations close to this spot gave readings of 51 ±3 dpm/100 $cm^2$ and 83 ±19 dpm/100 $cm^2$. Where ever possible the site health physicist verified the high readings to provide an independent confirmation.

In addition to building 146 field experiment, the background subtraction CSM were also used to monitored concrete floor in building 324 at TA-21. Instrumental background were recorded at 62.2 fA and a total of 26 readings were taken over an 89 $m^2$ area. The result shows activity ranging from 0-30 dpm/100 $cm^2$. Again, this is equivalent to "normal" concrete.

## CONCLUSION

The task of waste minimization of concrete surfaces and structures requires detectors which are sensitive, rugged, operate in real time, *in-situ*, and capable of measuring large surfaces. Concrete surface monitors have been designed to meet those requirements in addition to being cost effective. Using these CSMs, characterization of concrete surfaces and structures can be accomplished effectively and efficiently.

## ACKNOWLEDGMENTS

This work was supported by the US Department of Energy and Los Alamos National Laboratory.

## REFERENCES

1. G. F. KNOLL, "Radiation Detection and Measurement" 2nd ed. (New York: John Wiley & Sons, Inc., 1989), pp 131-132.
2. T. Q. VU, K. S. ALLANDER, R. D. BOLTON, and J. A. BOUNDS, "Application of the Long-Range Alpha Detector For Site Characterization Technology," published in WM'94 Conference Proceedings, Tucson, Arizona, Feb. 27-Mar 3, 1994. Pg 891-894..
3. D. W. MACARTHUR, K. S. ALLANDER, J. A. BOUNDS, R. W. CARESS, and, D. A. RUTHERFORD, "LRAD Surface Monitors," LA-12524-MS, Los Alamos National Laboratory (February 1993).
4. K. S. ALLANDER, J. A. BOUNDS, and D. W. MACARTHUR, "Application of the Long-Range Alpha Detector (LRAD) to the Detection of Natural-Occurring Radioactive Materials (NORM)," Published in WM'94 Conference Proceedings, Tucson, AZ, Feb 27-Mar 3, 1994, Pg 1425-1428.
5. M. W. RAWOOL-SULLIVAN, K. S. ALLANDER, J. A. BOUNDS, J.E. KOSTER, D. W. MACARTHUR, L. L. SPROUSE, D. STOUT, J. A. VACCARELLA, and T. Q. VU, "Field Study of Alpha Characterization of D&D Site Using Long-Range Alpha Detectors," submitted to American Nuclear Society, November 1994.
6. D. S. Stout, "Decommissioning of Surplus Facilities at Los Alamos," submitted to WM'95, Feb 26-Mar 2, 1995.

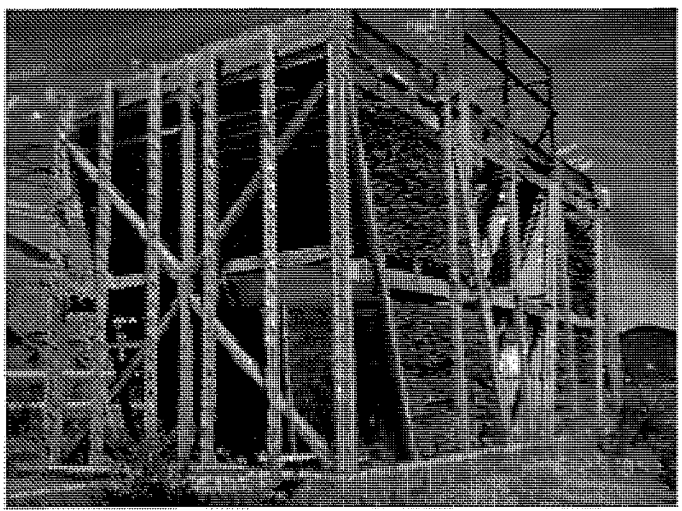


Fig. 2