

# *3-DISS for Depleted Uranium Recovery*

---



Environmental Restoration Group, Inc.  
8809 Washington St. NE  
Albuquerque, NM 87113

**Kenneth R. Baker, Ph.D.**  
**Environmental Restoration Group, Inc.**

**3-DISS Monitoring System**

The ERG 3-dimensional survey system (3-DISS) records radiation data along with the position of the detector automatically at prescribed intervals. The position of the detector is determined by placing infrared fan lasers in the area. The sensor requires line of sight to two lasers to determine its location with sub-centimeter accuracy. Data are downloaded into ArcView GIS computer application for data processing and presentation.

An array of eight detectors has been designed with the detectors placed at 4 inches above the soil surface. A separation of approximately 3 inches exists between each of the eight detectors in the array, producing a scan width of 5 feet. This configuration allows for scanning 100 percent of the area. Figures 1-3 show the system in operation.

Studies using DU fragments indicate that measurements made on 3-inch thick layers of potentially contaminated soil provide reasonable detection probabilities. A compacted clean dirt pad is proposed where 3-inch layers of soil will be applied using conventional equipment. The layer will be surveyed and the fragments (or areas with diffuse contamination) removed. After removal, these areas may be resurveyed and the new data patched into the data base with the data set being used as final status survey data.

The detector array has been placed on a small trailer pulled by a John Deere tractor with a hydrostatic transmission. The tractor has a cruise control feature that allows one to set a variable speed as slow as 1 inch per second. In order to obtain acceptable data spatial resolution, while achieving acceptable productivity, a speed of 4-5 inches per second has been adopted and a counting interval of 3 seconds. Scaler outputs from each detector are recorded along with the position at the end of the counting interval. This should assure that the coordinates of all "hits" will be known to within 15 inches. The coordinates of the hits can be downloaded into a hand-held unit and the unit used to navigate back to the locations. For discrete fragments, a hand-held trowel and radiation detector may be used to locate and remove the fragment from the thin soil layer. After removal, this unit may be used to resurvey the area. The new data will replace the original data with the entire data set used as the Final Status Survey. Before and After DU Recovery data plots are shown on the attached Figures 4 and 5.

**DU Fragment Detection Efficiency**

Samples of DU fragments ranging up to 48.5 grams were used for efficiency measurements. Three-inch by three-inch and 2-inch by 2-inch NaI detectors were used to measure the detection efficiency with the sources covered by varying depths of local desert soils and the detector stationary above the fragment. The results were compared to that obtained using FIDLER detectors. For all measurements, the FIDLER detectors were far superior to the other NaI detectors. Attachment A presents the FIDLER data where the top table presents the gross counts for a 1-minute counting interval. The sources were buried at various depths and the detectors

were placed at two heights above the ground surface (4" and 18"). The background count rate of 15,192 was subtracted from the gross values and reported as net counts per minute.

The lower portion of the table in Attachment A subtracts the background count rate and normalizes the net count rate to the mass of the particle by dividing by the mass. Note that the smallest and the largest fragment were not used. The smallest fragment could not be weighed accurately on our scale that reported to 0.1 g. The response to the largest fragment was very low, indicating that the size was large enough for self attenuation or perhaps it was an alloy that was different. Therefore the average net counts per minute per gram of DU was calculated without the data from the smallest and largest fragment used in the study.

The average net result for detectors placed at 4 inches above ground surface proved to be far superior for point sources and thus these data were used in our analysis. The ERG 3-dimensional survey system (3-DISS) has been designed with the detectors placed at 4 inches above the soil surface. A separation of approximately 3 inches exists between each of the eight detectors in the array, producing a scan width of 5 feet. The average net counts per minute per gram of DU was measured to be 9329, 2,000, and 1293 when the source was buried beneath 0, 1 inch, and 3 inches of local desert soils. This corresponds to 466, 100, and 65 counts/3-second interval.

The proposed operation of the 3-DISS is to move the array of eight FIDLER detectors at a rate of 4-5 inches per second, recording the scaler output and coordinates for each of the detectors at 3-second intervals. Probabilities for detection of DU fragments as a function of mass are available for fragments beneath 0, 1 and 3 inches of soil. Naturally, 11 grams or larger size fragments will be detected with a probability of 90 percent or more even if beneath 3 inches of soil; very small particles (1-2 grams) are easily detected on the surface with a detection probability of better than 90 percent. A case can be made using assumed fragment sizes that the average concentration in the soil will be much less than SNL's DCGL. This will be better predicted once more operational data are available. Confirmatory sampling and analysis will be done by SNL.

**Attachment A**

**FIDLER Detector**

|                 |                | Height of Detector Above Ground Surface |       |       |                              |      |      |
|-----------------|----------------|---|-------|-------|------------------------------|------|------|
|                 |                | 4"                                      |       |       | 18"                          |      |      |
| Fragment Number | Weight (grams) | Net Counts at Fragment Depth            |       |       | Net Counts at Fragment Depth |      |      |
|                 |                | Surface                                 | 1"    | 3"    | Surface                      | 1"   | 3"   |
| 1               | 0.0            | 22                                      | 106   |       | -111                         | -170 |      |
| 2               | 0.4            | 3913                                    | 847   | -85   | -518                         | -460 | -665 |
| 3               | 1.0            | 7620                                    | 1428  | 411   | 170                          | -100 | -382 |
| 4               | 2.0            | 21019                                   | 3783  | 2585  | 820                          | -2   | -98  |
| 5               | 3.1            | 26447                                   | 5880  | 3902  | 1517                         | 416  | 90   |
| 6               | 4.0            | 38300                                   | 8444  | 5580  | 1909                         | 826  | 188  |
| 7               | 4.9            | 49590                                   | 11406 | 6066  | 2766                         | 852  | 681  |
| 8               | 10.0           | 96903                                   | 17964 | 12743 | 4533                         | 2213 | 1423 |
| 9               | 15.0           | 113242                                  | 29611 | 19442 | 5790                         | 3190 | 2081 |
| 10              | 48.5           | 71903                                   | 25978 | 25374 | 4476                         | 3949 | 2169 |

|                 |                | Height of Detector Above Ground Surface |       |      |                                |        |       |
|-----------------|----------------|---|-------|------|--------------------------------|--------|-------|
|                 |                | 4"                                      |       |      | 18"                            |        |       |
| Fragment Number | Weight (grams) | Net CPM/gram at Fragment Depth          |       |      | Net CPM/gram at Fragment Depth |        |       |
|                 |                | Surface                                 | 1"    | 3"   | Surface                        | 1"     | 3"    |
| 1               | 0.0            | 2200                                    | 10600 |      | -11100                         | -17000 |       |
| 2               | 0.4            | 9783                                    | 2118  | -213 | -1295                          | -1150  | -1663 |
| 3               | 1.0            | 7620                                    | 1428  | 411  | 170                            | -100   | -382  |
| 4               | 2.0            | 10510                                   | 1892  | 1293 | 410                            | -1     | -49   |
| 5               | 3.1            | 8531                                    | 1897  | 1259 | 489                            | 134    | 29    |
| 6               | 4.0            | 9575                                    | 2111  | 1395 | 477                            | 207    | 47    |
| 7               | 4.9            | 10120                                   | 2328  | 1238 | 564                            | 174    | 139   |
| 8               | 10.0           | 9690                                    | 1796  | 1274 | 453                            | 221    | 142   |
| 9               | 15.0           | 7549                                    | 1974  | 1296 | 386                            | 213    | 139   |
| 10              | 48.5           | 1483                                    | 536   | 523  | 92                             | 81     | 45    |
| Average         |                | 9329                                    | 2000  | 1292 | 463                            | 158    | 75    |

Note\*: Average is for fragments between 2.0 and 15.0 grams only.



Fig 1. Array of 8 FIDLER detectors trailered behind tractor



Fig 2. Returning to hot spots using handheld 3-DISS sensor and laptop

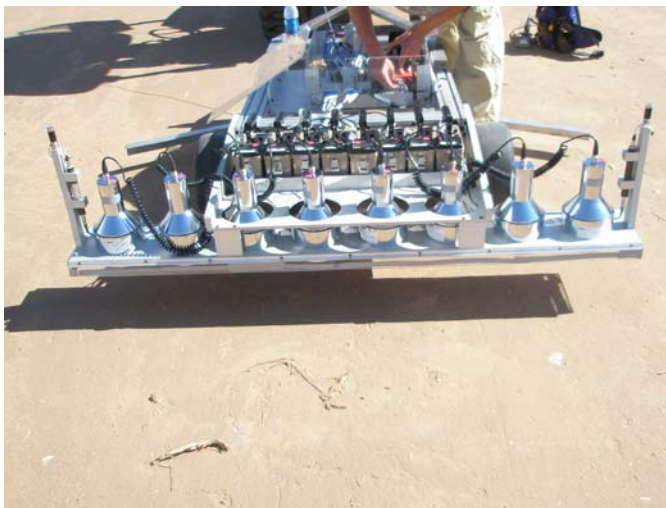


Fig 3. Detailed view of detector array and 3-DISS sensors

# Before and After Surveys of 3-DISS Scanning Pad Sandia National Laboratories Long Sled Track



Fig 4. Scanning Pad Initial Survey

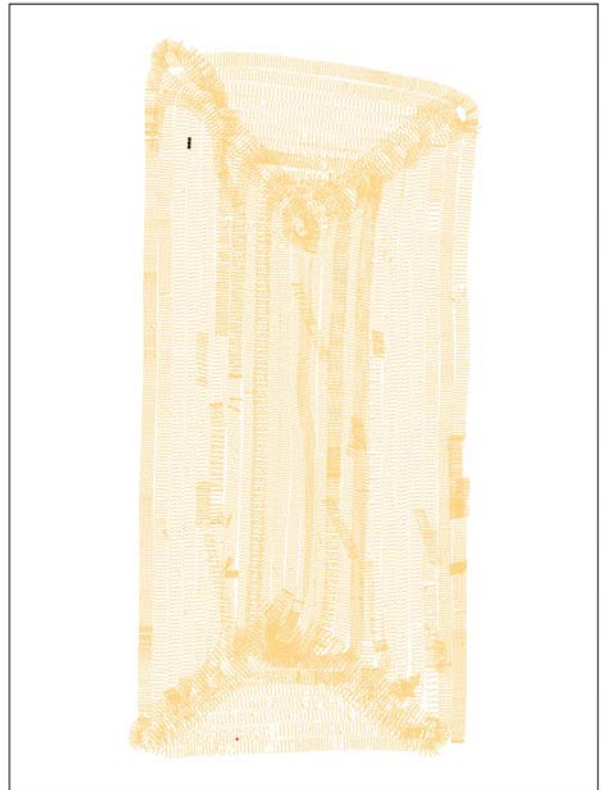


Fig 5. Scanning Pad Post-Remediation Survey