UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
SAM NUNN ATLANTA FEDERAL CENTER
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ATLANTA, GEORGIA 30303-8931

August 23, 2000

MEMORANDUM TO: Larry W. Camper, Chief
Decommissioning Branch
Division of Waste Management

FROM: Jay L. Henson, Chief
Materials Licensing and Inspection Branch 2
Division of Nuclear Materials Safety

SUBJECT: CONTRACTOR SURVEY WORK PLAN FOR DEPLETED URANIUM (DU) PENETRATORS, VIEQUES NAVAL TARGET RANGE, LIVE IMPACT AREA, VIEQUES, PUERTO RICO

The purpose of this memorandum is to provide, for your information, a copy of the "Contractor Survey Work Plan for Depleted Uranium (DU) Penetrators, Vieques Naval Target Range, Live Impact Area, Vieques, Puerto Rico." The Navy provided this document to Region II, by facsimile, on August 18, 2000. The Navy's contractor plans to arrive on Vieques the week of August 28, 2000, and expects to be performing DU recovery operations on the Navy's firing range there through the month of September 2000. Region II plans to perform inspections of the Navy's contractor, in Vieques, during that time.

This document modifies the Navy's original "Survey Work Plan," which was reviewed by your staff (TAR response dated March 20, 2000). Region II has reviewed this "modified plan" and determined that it is not significantly different from the Navy's original plan. Furthermore, Region II has determined that the procedures and methods described in the plan should be adequate to detect and recover remaining DU penetrators on the Navy's firing range.

Should you have any questions, please contact us.

Attachment: As stated

cc w/att: J. Hickey, NMSS

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SURVEY WORK PLAN

For

Depleted Uranium (DU) Penetrators
Vieques Naval Target Range, Live Impact Area
Vieques, Puerto Rico

Prepared By

New World Technology
448 Commerce Way
Livermore, CA 94550

Modified from Original Survey Plan Prepared By:

NAVAL SEA SYSTEMS COMMAND DETACHMENT
RADIOLOGICAL AFFAIRS SUPPORT OFFICE
YORKTOWN, VIRGINIA

Rev. 0: August 8, 2000

Enclosure

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Glossary of Acronyms, Abbreviations and Symbols

AFWTF	Atlantic Fleet Weapons Training Facility
Cpm	counts per minute
DC	direct current
DCGL	Derived Concentration Guideline Level
DGPS	Differential Global Positioning System
DOT	US Department of Transportation
DU	depleted uranium
EOD	Explosive Ordnance Disposal
HV	high voltage
KeV	kiloelectron volt
L_D	detection limit
LIA	Live Impact Area
MDA	minimum detectable activity
MeV	megaelectron volt
Mm	Millimeter
Mrem	Millirem
NaI	sodium iodide
NAVSEADET RASO	Naval Sea Systems Command Detachment, Radiological Affairs Support Office
NIST	National Institute of Standards and Technology
NWT	New World Technology
OSC	US Army Operations Support Command
Pa	Protactinium
PCB	polychlorinated biphenyl
PCi	Picocurie
PCi/g	picocurie per gram
PM	Project Manager
POC	point of contact
RF	Radio frequency
TEDE	total effective dose equivalent
Th	Thorium
U	Uranium
UXO	unexploded ordnance
V	Volt

1.0 EXECUTIVE SUMMARY

On February 19, 1999, two U.S. Marine Corps A/V-8 Harrier aircraft fired 263 rounds of 25 mm depleted uranium (DU) ammunition on the Live Impact Area (LIA), Atlantic Fleet Weapons Training Facility (AFWTF) on the island of Vieques, Puerto Rico. The LIA is approximately a 2.5 square mile live-fire training range used by the Navy and Marine Corps for aircraft, ship and amphibious assault fire exercises. The affected area was isolated to a portion of the LIA called the North Convoy Site. A team lead by Navy health physicists was dispatched to Vieques (North Convoy Site) between 10 and 19 March 1999, to locate and recover as many DU rounds as possible. The team recovered 57 rounds during this period, then had to leave do to logistic constraints.

Navy health physicists again returned to the site in May-June of 2000 and recovered additional detectable DU penetrators (approximately 37 additional rounds). That team conducted a 100% high-density scan of available sections of the affected area using sodium iodide detectors. All areas that were distinguishable from background, above the minimal detectable count rate (MDCR) were investigated. The approximate total number of rounds recovered to date is 94.

The Navy team must contend with several challenges before and during surveys of the North Convoy Site. Most importantly, the team must carefully weight the risk to survey/cleanup personnel with the risk to an average member of the critical group. Typically, dose modeling is used to estimate the total effective dose equivalent (TEDE) to an average member of the critical group from residual radioactivity. The critical group means the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances. Ultimately, the TEDE corresponds to an acceptable risk factor for the critical group. This acceptable TEDE is 25 mrem per year. The concentration of residual radioactivity distinguishable from background that if distributed uniformly throughout a survey unit would result in a TEDE of 25 mrem per year is called the derived concentration guideline (DCGL). Ideally, the objective of the team would be to perform a final status survey to demonstrate compliance with a DCGL. Unfortunately, current computer dose/risk models, even using site specific parameters, can not derive a DCGL for the situation on Vieques. But, since there are no exposure pathways (internal or external from the DU penetrators), the Navy concludes that the TEDE to the average member of the critical group (range personnel who periodically refurbish the Site) is 0 mrem per year. This equates to a risk factor of less than 10^{-6}. However, this Site does contain unexploded ordnance (UXO) that does present a greater risk to members of the critical group and to survey/cleanup personnel. Generally, UXO risk evaluations take a conservative approach and assume that the consequences of UXO detonation are serious injury or death. The exact risk from UXO at the North Convoy Site is being assessed and will continue to be assessed during the survey. This assessment must be considered and balanced against the potential risk and the degree of risk reduction that could be achieved by removing the DU penetrators. Furthermore, all brush in the survey area will have to be removed or cut to a height not to exceed four inches prior to the survey to allow survey teams full access.

This Radiological Survey Work Plan describes the methods and activities to be performed during the survey of the North Convoy Site, LIA, Vieques.

2.0 PURPOSE

Conduct a scan survey of the affected area and remove all detectable DU penetrators, fragments and contaminated soils. The survey equipment combines a commercial Differential Global Positioning System (DGPS) and a data collection/management system utilizing commercial radiation detection equipment.

3.0 HISTORY

On February 19, 1999, during a training exercise on the Live Impact Area of the Vieques Inner Range on Vieques, Puerto Rico, two U.S. Marine Corps Harrier aircraft expended 263 depleted uranium (DU) 25-mm rounds. Each 25-mm round contains 148 grams of DU in the form of a pencil shaped penetrator. The Live Impact Area is located on the eastern tip of the island of Vieques and covers approximately 2.5 square miles (see Figure 1). Interviews with the Marine pilots isolated the affected area to a small portion of the LIA called the North Convoy Site (see Figure 2).

The Harrier aircraft approached the North Convoy Site from the south, firing on targets in a northern direction. Each Harrier was loaded with 200 rounds. The Harriers made one pass over the Site. One Harrier expended all 200 rounds; the other Harrier expended only 63 round due to a gun jam. The pilots stated that their line-of-fire extended past the northern edge of the North Convoy Site into the brush area between the Site and the edge of the island. One pilot stated that his line-of-fire could have extended into the sea (see Figure 3).

4.0 DESCRIPTION OF THE SITE

The Live Impact Area is located on the East End of Vieques. The North Convoy Site is on the northeast side of the LIA. As shown in Figure 3, the Site is completely clear of vegetation and the soil is a mixture of sand and small rocks. Targets (a convoy of armored vehicles) are located on a hill, approximately centered on the Site. The hill slopes steeply downward toward the south, east and west, and slopes gradually in the north direction. The area north of the North Convoy Site extends from the Site's north edge to the edge of the island (or to the sea). This area is covered with thick patches of mesquite vegetation and small palm trees. The soil is composed of a mixture of sand and limestone rocks. Both these areas are littered with metal debris, some unexploded ordinance, and contain several large craters.

For brevity, both these sites will be referred to collective as the North Convoy Site. Accounts of the incident and a previous site investigation indicate that only a limited section of the North Convoy Site was actually affected. Penetrators were located along two distinct paths radiating from the targets in a northern direction. This pattern corresponded to the direction of fire employed by both Harrier pilots. This narrows the actual affected area to approximately 9.5 acres (see Figure 3).

5.0 PREVIOUS RADIOLOGICAL INVESTIGATIONS

A team lead by Navy health physicists was dispatched to Vicques between 10 and 19 March 1999 and again between May and June 2000, to locate and recover as many DU penetrators as possible. Visual searches and radiological surveys of the North Convoy site confirmed the location of penetrators along two general paths radiating from the targets (starting between two armored tanks) in a northern direction (see Figure 3). Buried penetrators were detected radiologically using a 2 inch by 2 inch sodium iodide and pancake G-M detectors.

The team recovered a total of 94 DU penetrators, most of them completely intact. Due to the low trajectory of the Harriers, although several penetrators were located near the targets, the majority of penetrators were located north of the targets within the brush. Penetrators were located approximately 10 to 20 feet apart. About 20% of the penetrators recovered were located on the surface, the rest were buried in the soil at an average depth of 6-8 inches (see Figures 4). Several penetrators were buried up to 18 inches in loose soil. A few holes exhibited residual contamination after the penetrator was removed. In each of these cases, part of the penetrator had fractured into smaller pieces.

The soil covering the North Convoy Site can be classified as sandy. It is dry, has a coarse texture and consists of large particles with uneven surfaces and large pore spaces. This makes the soil loose and easy to work. Background radiation readings of the soil ranged from 2,000-4,000 cpm.

A radiological scan survey of the North Convoy Site, out to the perimeter of the brush, was conducted using a 2 inch by 2 inch sodium iodide detector following the recovery of all penetrators. No additional penetrators or residual contamination were noted as a result of the radiological survey. Due to the dense vegetation and the possibility of hidden unexploded ordnance (UXO), detailed surveys were limited to the immediate vicinity of the cleared area of the North Convoy Site.

6.0 RADIOLOGICAL CONTAMINANT

The radiological contaminant of concern is depleted uranium. Depleted uranium is uranium metal that is the by-product of the uranium enrichment process. It is called depleted uranium because the amounts of the more radioactive forms of uranium have been reduced (depleted). This means its radioactive hazard has also been lessened. DU is almost entirely U-238 (99.8% U-238), and is 40% less radioactive than natural uranium found in air, water and soil. Because of its high density and strength, DU is used by the U.S. military in ammunition for armored shore vehicles, aircraft, and ships; as armored shielding for tanks; as counterweights in aircraft; and as radiation shielding in hospital nuclear medicine and radiation therapy clinics.

7.0 HEALTH EFFECTS REGARDING EXPOSURE TO DEPLETED URANIUM

The health risks associated with using DU in the peacetime military are minimal because DU is shielded and or intact. If the integrity of DU materials is compromised, such as when munitions are fired or armor is pierced, uranium can then react with other elements in the environment. This can create chemical reactions that may yield compounds with various chemical toxicities. Toxicologically, DU poses a health risk to the kidneys when internalized by ingestion or inhalation. The risk to the kidneys is similar to that from any other heavy metal such as lead, cadmium, or nickel. The toxicological health threat far out weights any radiological threat posed by DU.

The Navy has assessed the health consequences of the Vieques incident and has determined that the depleted uranium penetrators and minimal soil contamination do not pose an immediate safety concern to range workers or to the trespassers that occupied the Live Impact Area (LIA)[1]. Although civilian trespassers did have unimpeded access to the entire Atlantic Fleet Weapons Training Facility on Vieques, they were seldom observed for extended periods on the LIA but were seen transiting the access perimeter road. The trespassers were removed from the LIA in early May 2000.

The risk from incidental exposure to a depleted uranium penetrator does not pose a significant radiological hazard due to the low radioactivity of depleted uranium and the low energy photons emitted. Although many reports addresses health effects occurring from excessive ingestion or inhalation of depleted uranium, an individual on the range is very unlikely to receive such an intake. The depleted uranium penetrators already recovered were mostly intact or in fragments that are not respirable or easily ingested. External radiation exposure may also occur from contact with the bare skin. The current dose limit for skin would only be exceeded if unshielded DU remains in direct contact with the skin for more than 270 hours[1]. This type of exposure to the DU penetrators is very unlikely.

During the radiological surveys previously conducted, depleted uranium penetrators were removed from the area bounded in Figure 5. The balance of the penetrators are located in an area that is fairly inaccessible to people.

8.0 NON-RADIOGICAL CONTAMINANTS

The Atlantic Fleet Weapons Training Facility does support live-fire training operations. It does contain unexploded ordnance and explosive residues. A complete analysis of the range has not been performed, but it can be expected to contain contaminants typical of this type of range. These contaminants can include UXO, lead, mercury, beryllium, chromium, nickel, PCBs, oils and other petroleum products, antifreeze, and other organic compounds. The range is littered with scrap metal ranging in size from small pieces, which are a fraction of an inch in length to the remains of tanks, trucks, airplanes, and other target vehicles.

[1] Chief of Naval Operations (N455), Naval Radiation Safety Committee letter, Serial N455/9U595729 of 22 July 1999 to Nuclear Regulatory Commission, Region II (Ms. Anne Boland, Enforcement Officer).

9.0 SITE PREPARATION, EQUIPMENT AND PERSONNEL

9.1 Accessibility

All brush in the survey area will be removed or cut to a height not to exceed 4 inches prior to the scan surveys to allow survey teams full access. Because of the unexploded ordnance, access to the range requires an Explosive Ordnance Disposal (EOD) team clearance and escort prior to brush removal and survey. Access to the site will be limited to only those personnel engaged in the survey.

9.2 Electrical Power

There is no electrical power available at the range. Portable gasoline generators will supply electrical power as required.

9.3 Personnel

Project personnel will consist of the following:

Project Manager - Responsible for the overall operations and safety of the project team.

EOD/UXO Manager - Responsible for the clearance of UXO from the survey areas and safe operations during survey activities

Project Supervisors- Direct supervision of the project personnel.

EOD/UXO Technicians - Conduct sweeps and clearance activities in the survey area.

Health Physics Technicians - Perform surveys and removal operations for penetrator recovery.

Laborers/Range Technicians - Provide labor and UXO/penetrator removal assistance.

Navy Project Manager - Provides technical oversight and represents Navy interests during the project.

All NWT personnel are trained and experienced at the tasks to be performed.

10.0 RADIOLOGICAL SCAN SURVEY EQUIPMENT

This section describes the survey equipment to be used. Design of the survey and quality assurance are described in the following two sections.

10.1 Introduction

The survey methodology combines a commercial Differential Global Positioning System (DGPS) and data management system with commercial radiation detection equipment. The Data

Logger instrumentation records the count rate for the location acquired during scan surveys in an internal memory buffer. The DGPS system produces real-time positioning for the survey data that is collected based on grid coordinates and penetrator location.

10.2 Detectors

The gamma detector to be used is a Ludlum Model 44-10, containing a sodium iodide crystal (approximately 6 cubic inches in size.) This detects gamma rays with energies from 60keV to 3MeV. When a gamma ray is detected, the detector (and electronics) registers one count. Counts are electronically integrated, and recorded in units of counts per minute (cpm.)

10.3 Data Collection

Count rate data will be automatically collected in the memory buffer of the ratemeter/scaler. The ratemeter/scaler to be used is the Ludlum Model 2350-1 (or Model 2350) data logger. The data collection rate will be set to every 2 seconds. That is, while walking the survey grid, a reading will be collected every 2 seconds. Location information (grid ID) will be entered into the data logger by the technician, at the start of each grid. At least once per day, logged data are downloaded to a laptop computer, at the site. Once the data is successfully downloaded, the data logger's memory will be cleared. Each data point carries a time/date stamp, detector information and scaler information.

10.4 Geographic Positioning

In addition, a recording global positioning system (GPS) will be used to locate the centerline of the survey unit, and record the coordinates of any discovered rounds/fragments. The unit selected for the GPS is the Trimble "Pathfinder Pro XRS" Model 29756-87-ENG, differential GPS.

10.5 Multi-Purpose Digital Survey Instrument

The sodium iodide detectors are connected to the Ludlum Data Logger 2350 multi-purpose digital survey instrument. The Data Logger is operated in the Gross count mode for photon energies between 60 and 2000 keV. Operating in this mode enhances the signal from DU to signal from background radiation ratio because it records primarily DU specific photon energies. The count rate from the detector is stored to the Data Logger memory buffer.

11.0 RADIOLOGICAL SCAN SURVEYS

11.1 Radiological Surveys

Using the survey system described in Section 10 above and a forward scanning speed of 9 inches per second, and the detector(s) within 4 inches from the surface, the personnel will conduct a scan survey over the area identified in Figure 3. This area covers approximately 10 acres.

Detected penetrators/fragments will be recovered. The brush in the affected area will be cleared and a scan survey will be conducted.

11.2 Background Determination

The background radiation level(s) will be established on-site from an unaffected area or from readings in the actual survey area. Since the contamination is not uniformly dispersed over the survey area but consists of discreet sources, the survey area itself can be used as the background. Potentially contaminated areas will be identified relative to the local area background.

11.3 Scanning Minimal Detectable Count Rate (MDCR)

The minimum detectable number of net source counts in the scan interval required for a specified level of performance will be derived using the following equation.

$$MDCR = d'\sqrt{b_i}\,C$$

Where :

d' = index of sensitivity (α and β error)
b_i = number of bkgd counts in scan time interval
i = integrated scan interval (seconds)
C = 60/i used to convert to cpm

For example, we estimate the background count rate on Vieques is approximately 4,000 cpm. The instrumentation (see Section 10.0) uses a two second scan interval. Using an index of sensitivity of 1.38 (95% true positive rate and 60% false positive rate); the MDCR is 478 cpm (or 4478 cpm-gross).

11.4 The Detectability of DU

DU consists of 99.8% U-238 and 0.2% U-235. Also present are the short-lived progeny of these radionuclides, considered in secular equilibrium with their parents (i.e., having the same activity). U-238's short-lived progeny are Th-234 and Pa-234m, and U-235's daughter is Th-231.

The mass of a 25-mm DU penetrator is 148 g and therefore contains 147.7 g of U-238 and 0.3 g of U-235. Using a specific activity of 3.33×10^{-7} Ci g^{-1} for U-238 and a specific activity of 2.14×10^{-5} Ci g for U-235, the total activity of a penetrator is approximately 5×10^{-5} Ci. The photon emissions from DU are of most concern for detection purposes. DU's photon spectrum is shown in Table 1. Most of the photons emitted by DU have energies below 150 keV.

Using the computer program MicroShield®, the response of the detection system was evaluated. Dose rates were calculated for a DU round on the surface and buried in sand (1.5 g cm^{-3}) at depths of 3, 6, 9, and 12 inches. A measured conversion factor was used to convert mR h^{-1} to cpm in a 2"x2" sodium iodide detector. The estimated count rate at each depth was then compared to the MDCR (Table 2). As shown in Table 3, a 148 g penetrator buried in sand can be detected (i.e., exceeds the MDCR) at a depth of about 11 inches.

Table 1. DU Photon Emission Spectra

Nuclide	Energy (MeV)	Fraction	Nuclide	Energy (MeV)	Fraction	Nuclide	Energy (MeV)	Fraction
U-238	0.013	0.088	U-235	0.013	0.309	Th-231	0.013	0.708
	0.066	0.001		0.073	0.001		0.017	0.002
Th-234	0.013	0.096		0.090	0.027		0.026	0.147
	0.063	0.038		0.093	0.045		0.059	0.005
	0.092	0.027		0.105	0.021		0.073	0.002
	0.093	0.027		0.109	0.015		0.081	0.009
	0.113	0.002		0.120	0.002		0.082	0.004
	0.077	0.001		0.141	0.002		0.084	0.064
Pa-234m	0.013	0.001		0.144	0.105		0.090	0.009
	0.074	0.000		0.163	0.047		0.092	0.004
	0.014	0.004		0.183	0.004		0.096	0.006
	0.095	0.001		0.184	0.540		0.099	0.001
	0.098	0.002		0.195	0.006		0.102	0.004
	0.111	0.001		0.202	0.010		0.108	0.003
	0.766	0.002		0.205	0.047		0.163	0.002
	1.001	0.006		0.221	0.001		0.114	0.006
	0.926	0.004		0.190	0.009			

Table 2. Detectability of DU Penetrator in Sand – Compared to the MDCR

Depth in Sand (in)	Exposure Rate $\mu R\ h^{-1}$	Conversion Factor $cpm / \mu R\ h^{-1}$	Net Detector Response (cpm)	Net MDCR (cpm)
0	24	1315	31568	478
3	6	1315	7892	478
6	2	1315	2631	478
9	0.8	1315	1052	478
12	0.3	1315	395	478

With the detector located 4 inches above ground.

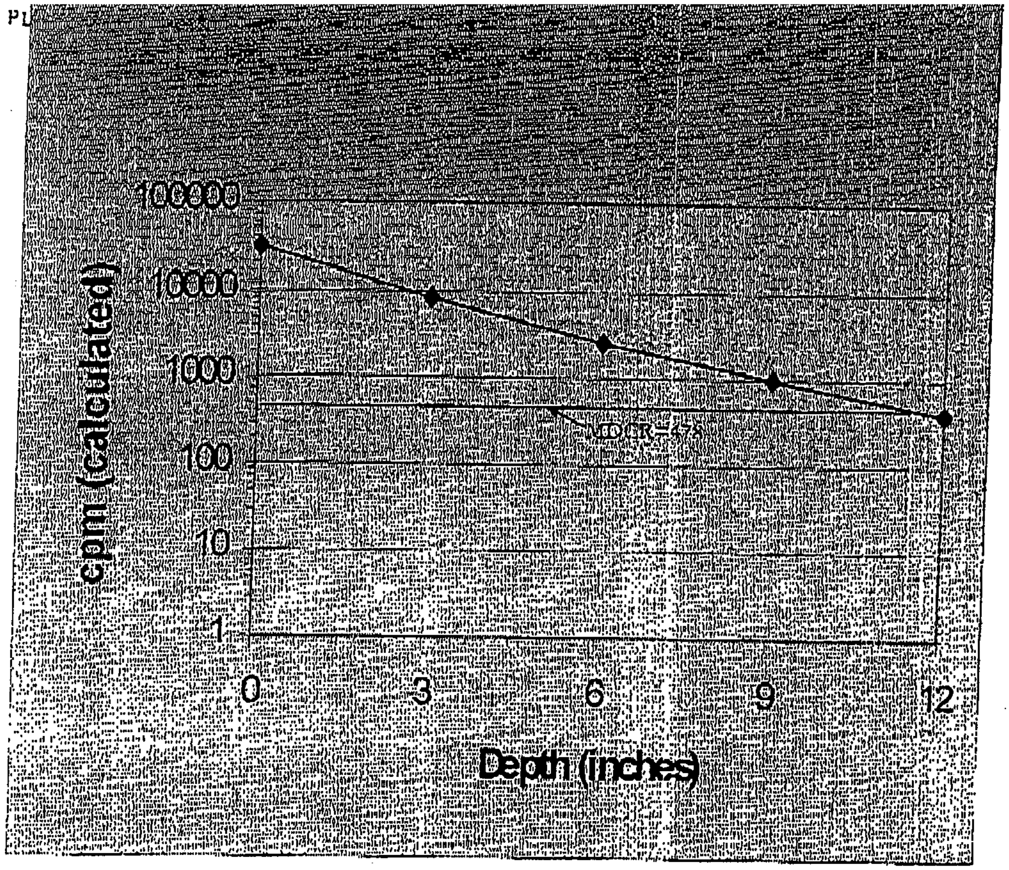


Table 3, Depth to Count Rate Evaluation

To validate the calculations in Table 2, NAVSEADET RASO performed a field study of the detector's ability to detect a 148 g and 70 g penetrator in sand. The experimental design is shown in Figure 6. The detection system's response was evaluated with a penetrator on the surface and buried at depths of 3, 6, 9, and 12 inches. The system was also evaluated with the position of the penetrator, centerline, at the beginning and middle of the scan interval. Additionally, the detector was offset at 2-inch increments up to 12 inches from centerline to determine the detector field of view.

This study verified that a 148 g penetrator buried in sand can be detected (exceeds the MDCR) at a depth up to 9 inches. The 70 g penetrator could be detected at a depth to 6 inches. Figure 7 illustrates these results. The offset, or detector's field of view, was determined to be 2 inches. The proposed instrumentation is sufficiently similar in design and operation to assume a similar response to the penetrators.

Potentially Contaminated Areas

Areas that exhibit readings above background (net counts that exceed the MDCR) and areas that have been remediated will be re-surveyed with the Data Logger/2X2 NaI detector. The minimum number of source counts required to support a detection decision for this scan stage can be estimated using the same methodology described in Section 11.3. The required rate of true positives remains high (95%), but fewer false positives (20%) can be tolerated, such that d' is now 2.45. If the survey interval is now increased to 4 seconds, the MDCR equals 600 cpm. Static readings will also be conducted to further reduce the MDC.

11.5 Data Analysis

Basic statistical quantities will be calculated for the data. The primary form of data reduction will be a histogram, showing the distribution of the data. An example is shown in Figure 8. This shows a distribution of background radium concentrations in soil, along with a number of higher level anomalies (above 3 pCi/gram). All areas that exhibit readings above background (net counts above the MDCR) will be investigated.

The second form of data reduction will be graphical display of the data. This will be performed using posting plots/maps. This will show the locations of any anomalies in the survey unit and will serve as a visual representation of the data.

These types of analyses of the scan data will be used to detect the locations of DU penetrators on Vieques.

All areas that exhibit readings above background (net counts above the MDCR) will be investigated.

12.0 QUALITY ASSURANCE

12.1 Project Description

To identify areas of elevated radioactivity on the North Convoy Site, LIA, Vieques, and determine whether these areas are due to DU penetrators.

12.2 Project Organization

The Project Manager will ensure that personnel involved in this project meet the necessary training requirements. Training and experience requirements will be based on the task to be performed.

Personnel authorized access to the North Convoy Site will receive appropriate explosive safety training and general training on hazards associated with conducting operations on an ordnance range from the NWT EOD/UXO Manager and Navy range personnel.

Personnel recovering DU penetrators will meet the requirements of ANSI 3.1 for both training and experience.

All site personnel are trained radiation workers and are familiar with the handling and storage of radioactive materials, contamination controls, the use of radiation survey equipment, and operations on areas containing unexploded ordnance.

12.3 Design of Data Collection Operations

Using knowledge of DU detection methods, a screening survey was developed and implemented. This screening involves measuring gamma radiation levels just above the soil surface. Gamma detection is useful for screening large areas.

The first step in the survey is to establish grids (approximately 100' x 100' and 100' x 150'), along which measurements will be made. The technician will walk back and forth within each grid, starting in the southwest corner, carrying the detector just above the ground. Readings will be recorded electronically, every 2 seconds. The grid identifier will be recorded at the start of each grid.

12.3.1 Equipment

The detector/scalers will be calibrated within 12 months of the start of work. Daily calibration checks will be performed, to assure that the equipment has not drifted out of calibration. This will be done using a check source, to which the detector has a known response. Daily checks will also include the following items:

- Battery voltage
- Cables
- High voltage to detector
- Speaker on the scaler
- Scaler display

12.3.2 Database Security

All of the raw data collected during the survey will be copied to floppy discs and safeguarded by the Project Manager. No copies of the data files will be made, unless authorized by the Navy.

12.3.3 Data Review

At least once per day, data are downloaded from each detector to a laptop computer, at the site. Then the data are examined to determine if any unusual readings were encountered. High readings, not noticed by the technician, may indicate the presence of DU. In that event, the location of the high reading will be re-visited and re-surveyed. The Team Leader will review all downloaded data. He will evaluate the validity of the results and the extent of coverage of the survey area.

12.3.4 Data Assessment

Basic statistical quantities will be calculated for the data. The primary form of data reduction will be a histogram, showing the distribution of the data. The second form of data reduction will be graphical display of the data. This will be performed using posting plots/maps. This will show the locations of any anomalies in the survey unit and will serve as a visual representation of the data. Such plots will also document the location of DU fragments found and removed. Quality will be assured by using validated computer programs to calculate statistics and plot the data (e.g., MSExcel).

13.0 HEALTH AND SAFETY PLAN

The NWT project Health and Safety Plan is presented at Appendix 1 to this work document.

The EOD/UXO operations and safety plan is presented at Appendix 2

14.0 DETAILED WORK AND SURVEY PROCEDURE

14.1 Purpose

The purpose of this procedure is to ensure that the work performed on the Vieques LIA is conducted in a controlled and safe manner.

14.2 References

NWT Project Health and Safety Plan

NWT Explosives Work Plan

Project Scope of Work

14.3 Materials

As detailed in the materials and equipment list.

14.4 Responsibility

The Project Manager, and his designated alternates, are responsible for the proper calibration of the instruments, completion of the Scope of Work, safe field operations, quality control for data collection and reporting on field activities following completion of the work effort.

14.5 Area Preparation

14.5.1 Site Preparation

a. Establish a site command area, consisting of shade shelters, crew assembly area and materials lay-down areas. The EOD manager will concur with area selection prior to any use of those areas.

b. Re-establish the center line reference point from previous site survey activities. All future reference coordinates will be based on this coordinate point.

c. Plot the initial grid corners, north and south, of the primary target area. Establish the GPS coordinates for the corner markers.

NOTE: All operations on the LIA will be under the direct observation of the Manager EOD and his designated alternates. NO WORK WILL BE PERFORMED IN NON-CLEARED AREAS WITHOUT EOD PRESENCE.

14.5.2 EOD Sweep

a. Beginning at the innermost grids, the EOD teams (2 EOD Technicians, 1 HP Technician and 1 Range Tech/Laborer) perform a surface sweep per the Explosives Work Plan.

b. Clear brush interference (manually) as necessary by direction of the EOD Technician.

c. Mark the boundaries of the grids during clearance activities. Grids will be established which measure 100 feet X 100 feet on the western side of the survey area and 100 feet X 150 feet on the eastern side, biased 50 feet eastward from the centerline of the survey area.

1) The assigned HP Technician will perform gross surveys of the areas, ***under the direction of the EOD team leader***, during the UXO sweep activities. Should a penetrator/fragment be discovered during this survey, mark it's location with a flag marker for removal and further survey following EOD clearance of that grid.

d. Scrap metals and removed brush will be piled for later removal as much as practical.

e. All "blow and go" operations will be performed in accordance with the Explosives Work Plan.

14.5.3 Brush and Scrap Clearance

CAUTION: Power brush clearing equipment presents a substantial risk of injury to operators and other personnel in the immediate area. Extreme caution will be used during operation of such equipment.

a. Following clearance of a specific grid for UXO, begin brush removal operations in that grid.

b. Brush clearing will be performed using power equipment (self-propelled brush hogs, hand held weed whackers, tractor mounted brush hog, chain saws) and manual equipment. Chipper/shredders will be centrally placed in each grid. As brush/trees are removed, they will be fed through the chipper/shredder. The discharge will be redirected as necessary to preclude "piling" of shredded material. A maximum height of two inches over any area is allowed to facilitate the scan survey. No intrusion below ground surface is permitted during brush removal operations without the consent of the Manager EOD and the presence of an EOD/UXO technician.

c. Scrap (metal casings, ordnance remains) will be removed from the survey area and placed immediately outside of the grid perimeter.

14.6 Survey

14.6.1 Instrument Preparation

a. Ensure that the Model 2350 and detector are within calibration.

b. Ensure that the instrument batteries are within operational limits.

c. Perform and record results of the daily source check.

d. Ensure the memory display indicates the appropriate information (date, grid number and project information) and that the previous survey data has been downloaded.

14.6.2 Survey

a. Traverse the grid to be surveyed by following parallel paths, adjacent but slightly overlapping.

b. Perform the walkover survey as detailed in section 10, 11 and 12 above.

c. Note the audible response of the meter. Should an increase in the count rate be observed, pause and obtain a static reading in the area of increase.

d. If the count rate indicates readings exceeding the MDCR presented above, visually inspect the immediate area for evidence of a penetrator (fragment, whole penetrator, surface depression, oxidized DU or hole in the surface). If no visual evidence is observed, notify the EOD technician and, under his guidance, investigate subsurface using hand tools. **NOTE: No below ground surface disturbance is authorized without the presence of an EOD/UXO technician as previous UXO clearance activities verified removal of surface ordnance only. Subsurface UXO is possible and likely in the LIA.**

e. Continue surveys until the designated area per the Scope of Work is completed.

14.7 Penetrator/Fragment Removal, Packaging and Shipping

14.7.1 Once a penetrator or fragment has been located, it should be removed using hand tools and rubber gloves. The soils immediately adjacent should also be removed but efforts will be made to limit the amount of soils taken to only those indicating some reading greater than background levels. **NOTE: No below ground surface disturbance is authorized without the presence of an EOD/UXO technician as previous UXO clearance activities verified removal of surface ordnance only. Subsurface UXO is possible and likely in the LIA.**

14.7.2 The penetrator, any fragments and removed soils will be placed in plastic 5 gallon plastic pails. The pails will be transferred to 85 gallon steel overpack drums. All packaged radioactive materials will remain on the LIA, in a designated storage area, until prepared for shipment.

14.7.3 Once site survey operations have concluded, the packaged waste will be labeled, surveyed and all appropriate manifests and shipping papers will be prepared in accordance with NWT/OSC shipping procedures.

14.7.4 The drums, once in compliance with applicable DOT regulations, will be transported by the Navy to NS Roosevelt Roads. NWT broker personnel will arrange shipping between NS Roosevelt Roads and the airport at San Juan. The drums will then be transported, via commercial carrier, to Washington State for ultimate disposal at the US Ecology site in Hanford WA.

15.0 DEMOBILIZATION ACTIVITIES

15.1 Site Breakdown

15.1.1 Remove all posting, markers and flags from the area. Dispose of appropriately or package for return shipping.

15.1.2 Remove and package all equipment and materials. Prepare for return shipping and transport to commercial carrier. Ensure crew dosimetry devices are collected and shipped for analysis.

15.1.3 Conduct exit briefings as requested

Figure 1. Live Impact Area on Island of Vieques.

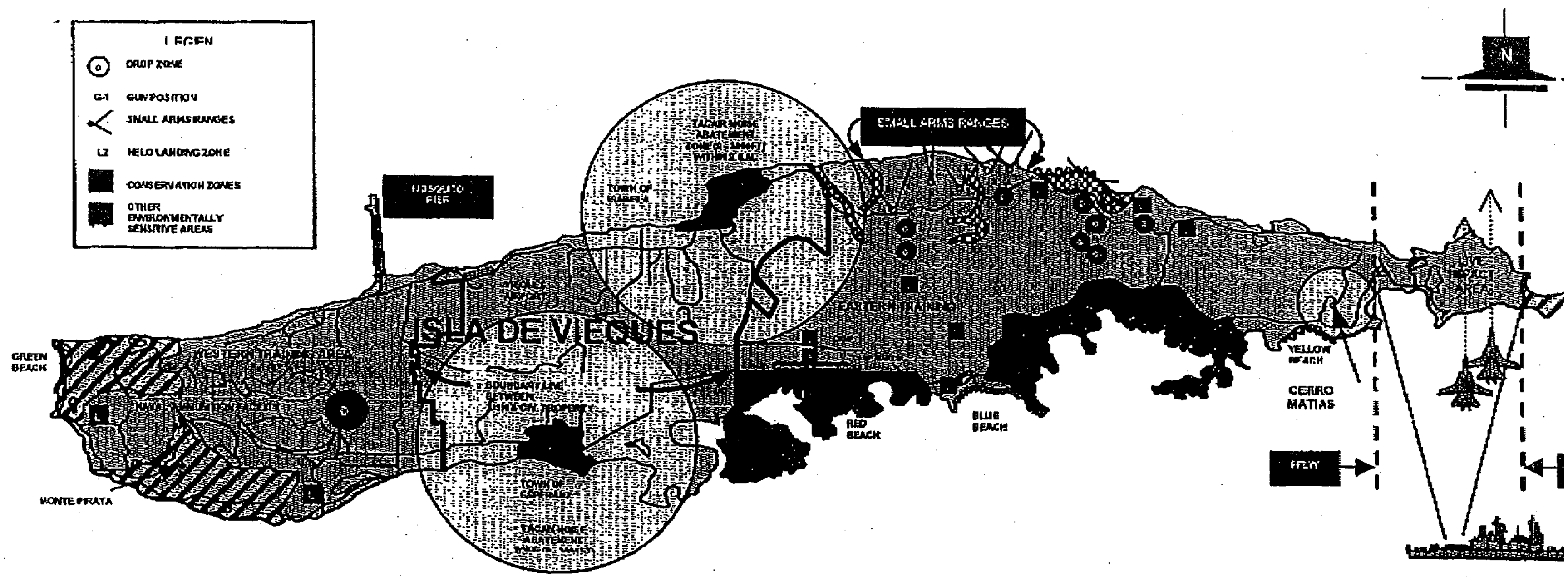


Figure 2. North Convoy Site.

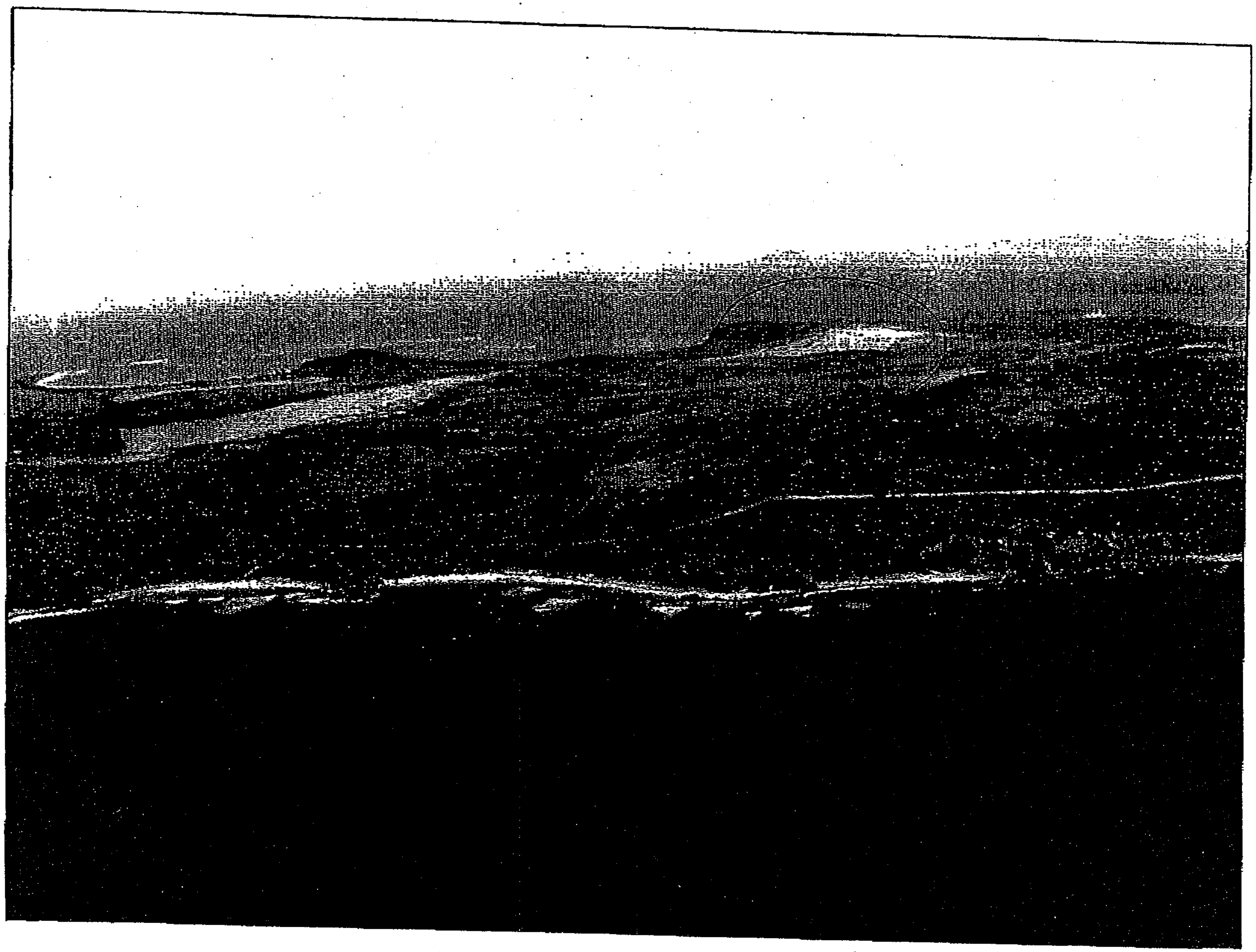


Figure 3. Affected Area of North Convoy Site & Harrier Aircraft Line-of-Fire.

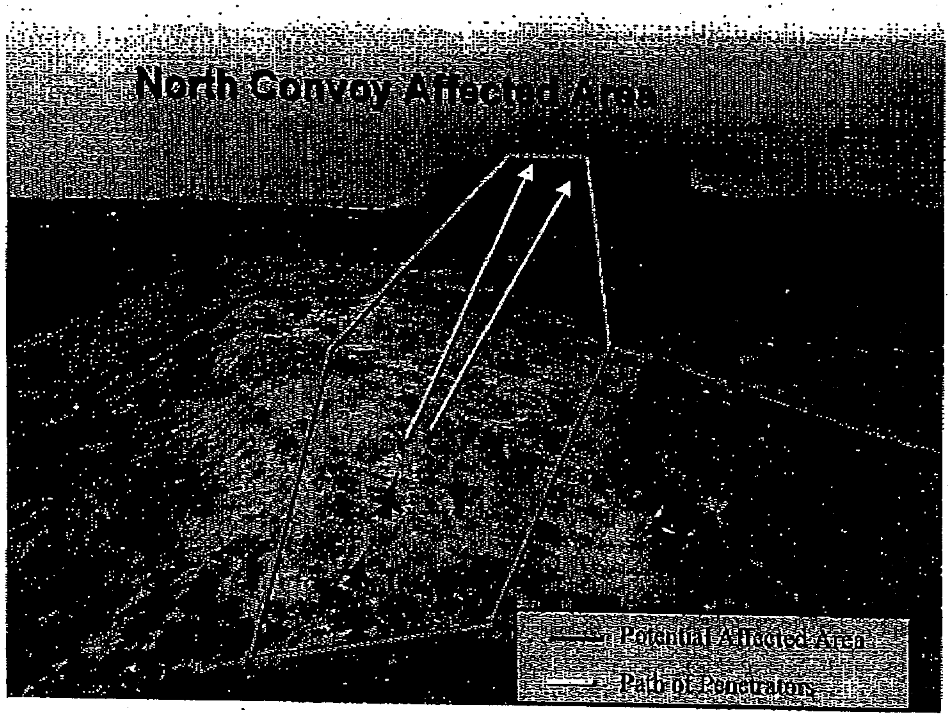
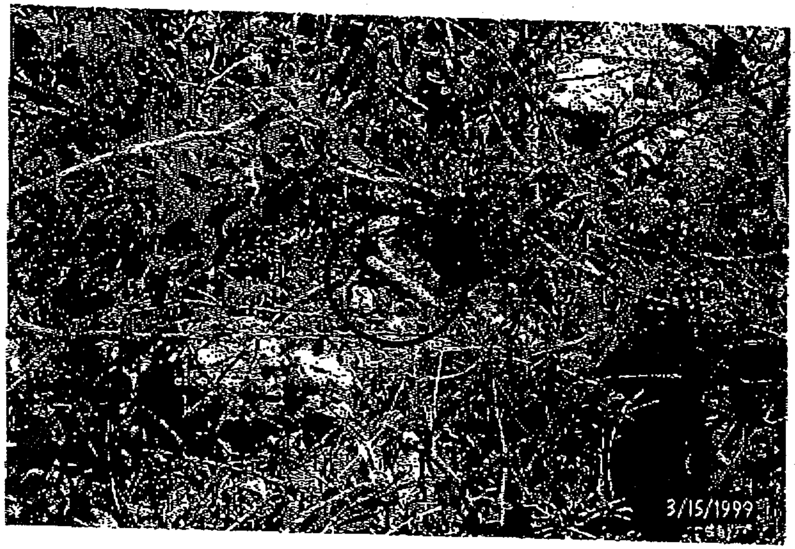


Figure 4. DU penetrators previously located on the North Convoy Site.

Penetrator located on the surface.



Penetrator located (buried) in soil.

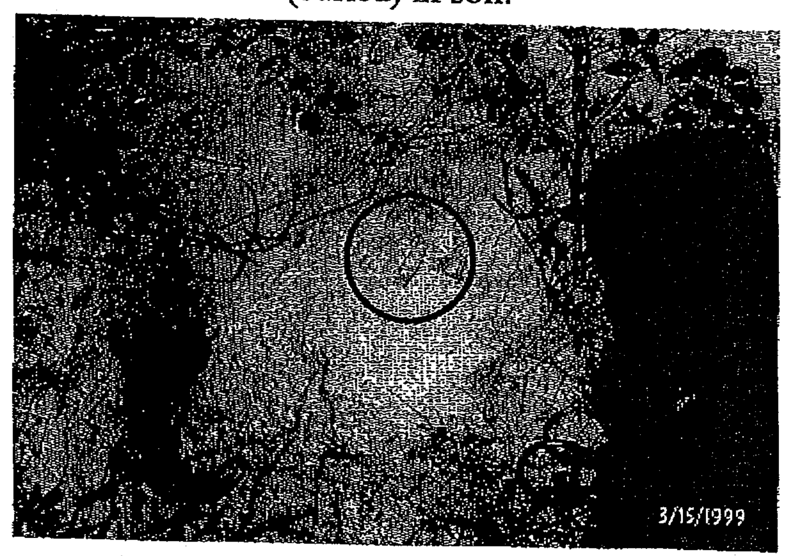


Figure 5. Area of Previously Found Penetrators.

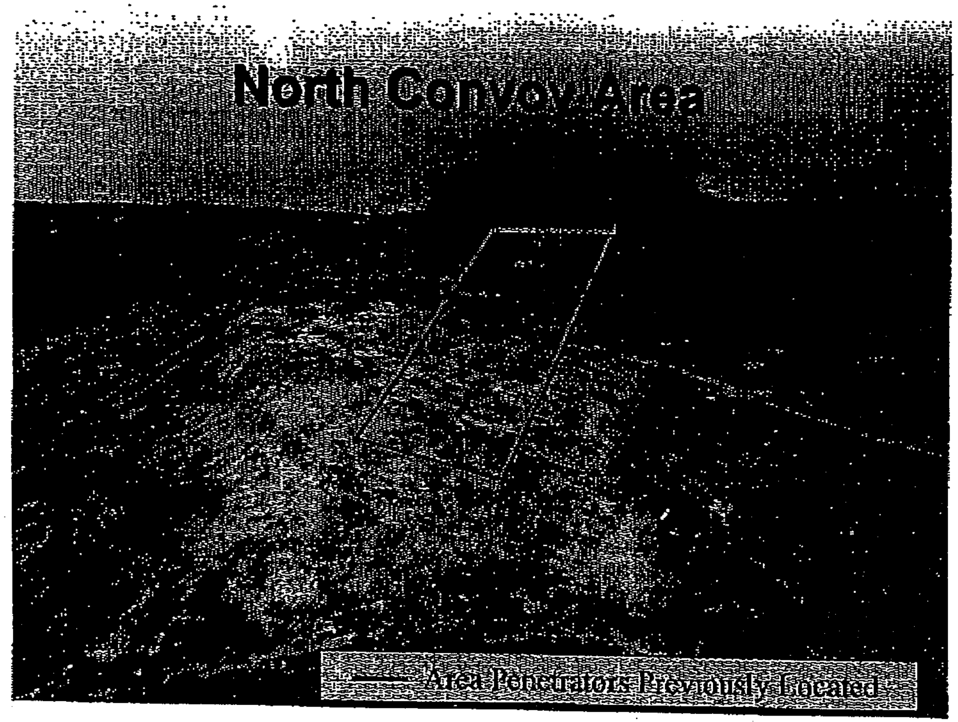


Figure 6. Field Study Design for Determining the Detectability of a DU Penetrator

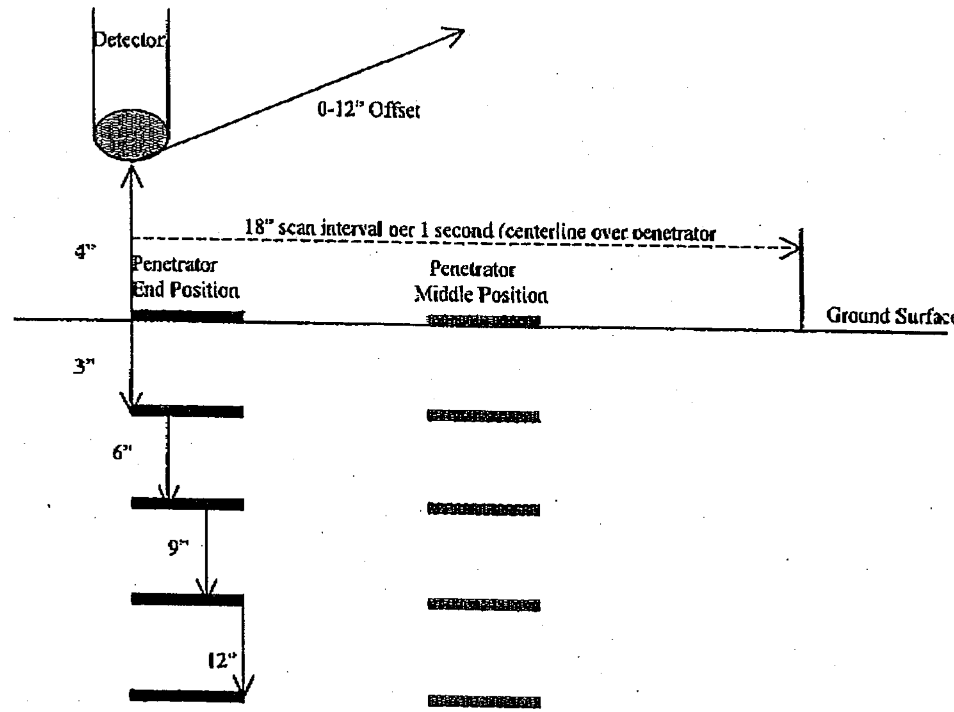
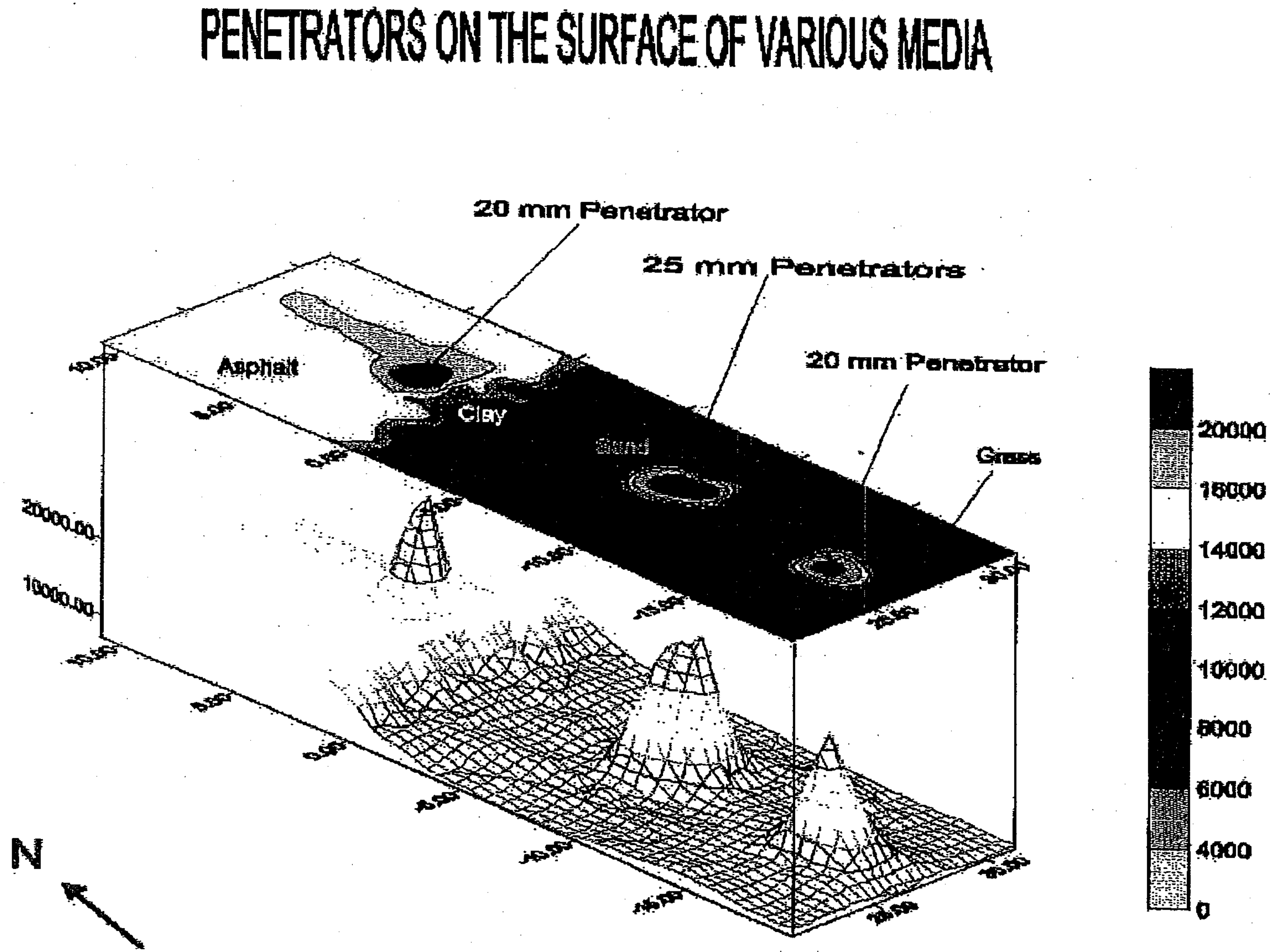


Figure 7. Stack Map Used to Analyze Scan Survey Data.



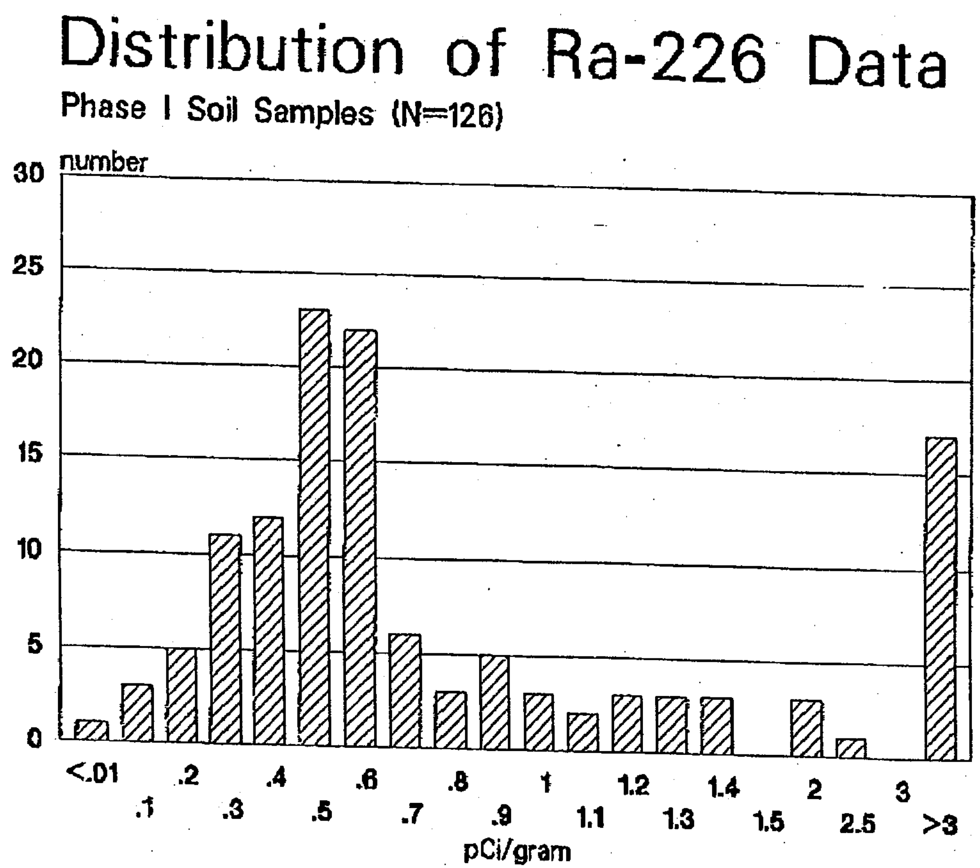


Figure 8. Example Data Histogram