NRC FORM 464 Part I
(6-1998)

U.S. NUCLEAR REGULATORY COMMISSION

RESPONSE TO FREEDOM OF INFORMATION ACT (FOIA) / PRIVACY ACT (PA) REQUEST

FOIA/PA	RESPONSE NUMBER
2000-0171	1

RESPONSE TYPE: ✓ FINAL ___ PARTIAL

REQUESTER: Jose O. Morales

DATE: MAY 16 2000

PART I. -- INFORMATION RELEASED

___ No additional agency records subject to the request have been located.

___ Requested records are available through another public distribution program. See Comments section.

___ APPENDICES ___ Agency records subject to the request that are identified in the listed appendices are already available for public inspection and copying at the NRC Public Document Room.

✓ APPENDICES A Agency records subject to the request that are identified in the listed appendices are being made available for public inspection and copying at the NRC Public Document Room.

___ Enclosed is information on how you may obtain access to and the charges for copying records located at the NRC Public Document Room, 2120 L Street, NW, Washington, DC.

✓ APPENDICES A Agency records subject to the request are enclosed.

___ Records subject to the request that contain information originated by or of interest to another Federal agency have been referred to that agency (see comments section) for a disclosure determination and direct response to you.

___ We are continuing to process your request.

___ See Comments.

PART I.A -- FEES

AMOUNT *
$
* See comments for details

___ You will be billed by NRC for the amount listed.

___ You will receive a refund for the amount listed.

✓ None. Minimum fee threshold not met.

___ Fees waived.

PART I.B -- INFORMATION NOT LOCATED OR WITHHELD FROM DISCLOSURE

___ No agency records subject to the request have been located.

___ Certain information in the requested records is being withheld from disclosure pursuant to the exemptions described in and for the reasons stated in Part II.

___ This determination may be appealed within 30 days by writing to the FOIA/PA Officer, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Clearly state on the envelope and in the letter that it is a "FOIA/PA Appeal."

PART I.C COMMENTS (Use attached Comments continuation page if required)

SIGNATURE - FREEDOM OF INFORMATION ACT AND PRIVACY ACT OFFICER

Carol Ann Reed

APPENDIX A
RECORDS BEING RELEASED IN THEIR ENTIRETY

NO.	DATE	DESCRIPTION/(PAGE COUNT)
1.	6/28/99	Letter to Department of the Navy from M Lesser, NRC, Subject: Allegation No. RII-1999-A-0080 (2 pages)
2.	8/6/99	Letter to Centers for Disease Control and Prevention from M Lesser, NRC, Subject: Allegation No. RII-1999-A-0080 (3 pages)
3.	2/1/00	Letter to Commonwealth of Puerto Rico from L Reyes, NRC (4 pages)
4.	3/21/00	Letter to Department of the Navy from M Lesser, NRC, Subject: Review of Survey Work Plan for Depleted Uranium (DU) Penetrators (29 pages)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
ATLANTA FEDERAL CENTER
61 FORSYTH STREET, SW, SUITE 23T85
ATLANTA, GEORGIA 30303-3415

June 28, 1999

Department of the Navy
Naval Radiation Safety Committee
Chief of Naval Operations (N-45)
ATTN: RADM A. Granuzzo
Chairman
Room 636
2211 S. Clark Place
Arlington, VA 22244-5108

SUBJECT: ALLEGATION NO. RII-1999-A-0080

Dear Admiral Granuzzo:

As discussed in a June 24, 1999, telephone conversation between Mr. Michael Fuller, Region II and LCDR John Pomerville of your staff, the U.S. Nuclear Regulatory Commission (NRC) recently received information concerning activities at Vieques Naval Range, Puerto Rico. A description of the concern is enclosed.

We request that you conduct inspections and/or investigations as appropriate to prove or disprove the concern and that you inform us within 30 days of the date of this letter of the resolution of this matter and make the records of your completed action available for NRC inspection.

NRC's evaluation of your response will include a determination that: 1) the individuals conducting the investigation were independent of the organization affected by the concern, 2) the evaluator was competent in the specific functional area, 3) the evaluation was of sufficient depth and scope to substantively address the concern, 4) appropriate root causes and generic implications were considered if the concerns were substantiated, and 5) the corrective actions, if necessary, were sufficient.

Please send your response to Ms. Anne Boland, Enforcement Officer, Enforcement and Investigations Coordination Staff, Region II, with no other copies to the NRC. Please do not submit your response to the Document Control Desk. Because your response may be provided to individuals expressing the concern, to the extent possible, it should not include any personal privacy, proprietary, or safeguards information so that it can be released without redaction. If your response contains personal privacy, proprietary, or safeguards information, such

RETURN RECEIPT REQUESTED
Z 353 109 032

ENCLOSURE CONTAINS INFORMATION
NOT FOR PUBLIC DISCLOSURE

A/1

information shall be contained in a separate attachment, appropriately marked, so that it will not be subject to public disclosure. The affidavit required by 10 CFR 2.790(b) must accompany your response if proprietary information is included.

Should you be unable to complete your review within the time requested, please contact us that we can discuss this matter and make appropriate arrangements.

The enclosure to this letter must be controlled as sensitive information and distribution limited to personnel with a legitimate "need-to-know."

If you have any questions regarding this matter, please contact Mr. Oscar DeMiranda, Senior Allegation Coordinator, at (404) 562-4424.

Sincerely,

Thomas R Decker for

Mark S. Lesser, Chief
Materials Licensing/Inspection Branch 2
Division of Nuclear Materials Safety

Docket No. 030-29462
License No. 45-23645-01NA

Enclosure: As stated

cc w/encl:
Oscar DeMiranda

~~ENCLOSURE CONTAINS INFORMATION NOT FOR PUBLIC DISCLOSURE~~

RII-1999-A-0080

ALLEGATION SUMMARY

DEPARTMENT OF THE NAVY

VIEQUES NAVAL RANGE

PUERTO RICO

CONCERN ABOUT PUBLIC EXPOSURE TO DEPLETED URANIUM MUNITIONS

NRC Region II recently received a concern pertaining to potential health hazards to the public from exposure to depleted uranium (DU) munitions and risk of unexploded ordinances to persons crossing the range boundaries and having begun living on the weapons firing range.

The concern is potential radiation hazard to the public from exposure to depleted uranium. Associated with this concern, the NRC Region II Office was informed by the Navy on March 5, 1999, that two U.S. Marine Corps aircraft expended 263 DU rounds at the Vieques Naval Range. Each round contains 148 grams of DU.

Enclosure

August 6, 1999

Centers for Disease Control and Prevention (CDC)
ATTN: Ms. Carol Connell, ATSDR
Mail Stop: E 56
1600 Clifton Road
Atlanta, GA 30333

SUBJECT: ALLEGATION NO. RII-1999-A-0080

Dear Ms. Connell:

This is in reference to our July 8, 1999 letter, which indicated that we would initiate action to review the concerns related to the potential health hazards to the public from exposure to depleted uranium munitions at the Vieques Naval Range on Vieques Island, Puerto Rico. The NRC referred the concerns you brought to our attention on June 8, 1999, to the Naval Radiation Safety Committee (NRSC) for follow up. We, in turn, evaluated the Navy's findings and have completed our review.

One component of the concern had to do with the risk associated with unexploded ordinance that may also be present on the range. This issue is beyond the purview of the NRC. We recommend that you contact the Navy directly to follow up on this issue. Our point of contact for the Navy is CDR Garry Higgins, Executive Secretary, NRSC. He may be reached at (703) 602-5365.

Enclosure 1 to this letter, Allegation Evaluation Report, lists the concerns and describes how the NRC and the NRSC resolved the concerns raised. Also included for your information is a copy of the report from the NRSC to the NRC dated July 22, 1999, (Enclosure 2), in which they describe their investigation into this matter and their conclusions.

Thank you for informing us of your concerns. We feel that our actions in this matter have been responsive to those concerns. We take our safety responsibilities to the public very seriously and will continue to do so within the bounds of our lawful authority. Unless the NRC receives additional information that suggests that our conclusions should be altered, we plan no further action on this matter. Should you have any additional questions, or if I can be of further assistance in this matter, you may contact me at 800/577-8510 or 404/562-4731, or by mail at P.O. Box 845, Atlanta, Georgia 30301.

Sincerely,

/S/

Mark S. Lesser, Chief
Materials/Licensing Inspection Branch 2
Division of Nuclear Materials Safety

Enclosures: 1. Allegation Evaluation Report
2. Letter dated July 22, 1999

RETURN RECEIPT REQUESTED
CERTIFIED MAIL NO. Z 353 109 035

OFFICE	RII:DNMS	RII:DNMS	RII:DNMS	RII:EICS	
SIGNATURE					
NAME	MFuller	MLesser	CHdsey	SSparks	
DATE	8/3/99	8/3/99	8/4/99	8/6/99	8/ /99
COPY?	YES NO	YES NO	YES NO	YES NO	YES NO

OFFICIAL RECORD COPY DOCUMENT NAME: A:\clse0080.wpd

A/2

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET, SW, SUITE 23T85
ATLANTA, GEORGIA 30303-8931

August 6, 1999

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Sincerely,

Mark S. Lesser, Chief
Materials/Licensing Inspection Branch 2
Division of Nuclear Materials Safety

Enclosures: 1. Allegation Evaluation Report
2. Letter dated July 22, 1999

RETURN RECEIPT REQUESTED
CERTIFIED MAIL NO. Z 353 109 035

ALLEGATION EVALUATION REPORT

ALLEGATION RII-1999-A-0080

CONCERN ABOUT PUBLIC EXPOSURE TO DEPLETED URANIUM MUNITIONS

DEPARTMENT OF THE NAVY
VIEQUES NAVAL RANGE
PUERTO RICO

DOCKET NO. 030-29462

ALLEGATION:

There are potential health hazards from exposure to depleted uranium (DU) munitions and unexploded ordnance to persons crossing the range boundaries and living on the Vieques Naval Range, in Puerto Rico.

DISCUSSION:

The U.S. Navy possess a Master Materials License (MML) which authorizes the Navy and Marine Corps to possess and use licensed radioactive materials for medical and industrial uses. The license was issued to the Chief of Naval Operations in 1987 and authorizes the Naval Radiation Safety Committee (NRSC) to issue radioactive material permits to Navy and Marine Corps users, and it is under the NRSC's oversight that users are inspected. The NRC monitors the Navy's implementation of the MML program through accompaniments of Navy inspectors, independent inspections by NRC inspectors, and periodic reviews of the overall program.

In accordance with NRC policy, allegations are generally referred to the NRSC unless they involve harassment and intimidation, or in cases where the NRSC is involved. This concern was referred to the NRSC for follow up.

The Navy's report acknowledges that individual members of the public crossed range boundaries and began residing there. Based upon a review of the Navy's report and other information available, the NRC has determined that the members of the public made the unauthorized entry into the range and began residing there on or about April 22, 1999. Although unsuccessful, the Navy has made an earnest attempt to encourage the individuals to leave.

The Navy has performed an assessment of the potential radiation dose that might be received by an individual present there and has concluded that it is highly unlikely that someone would receive a dose in excess of public dose limits, as described in 10 CFR Part 20.

CONCLUSION:

Based on the information provided, the allegation that individual members of the public have crossed the boundaries of the firing range on Vieques Island in Puerto Rico and are residing there, was substantiated. However, the NRC has reviewed the Navy's assessment of the potential dose to individual members of the public, present on the range, and agree that the individuals are not likely to receive radiation doses from the depleted uranium in excess of regulatory limits. This allegation is considered closed.

UNITED STATES
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REGION II
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET SW SUITE 23T85
ATLANTA, GEORGIA 30303-8931

February 1, 2000

Carmen Feliciano de Melecio, MD
Secretary of Health
Commonwealth of Puerto Rico
Call Box 70184
San Juan, PR 00936

Dear Dr. Feliciano de Melecio:

This is in response to your letter dated January 23, 2000, regarding the presence of depleted uranium ammunition and possible radiation contamination on the Navy's firing range on Vieques Island, Puerto Rico. We, like you, are concerned about the delay in the retrieval of the remaining uranium. We are committed to the prompt cleanup of remaining depleted uranium ammunition and associated contamination as soon as it can be done safely. As our staffs have discussed, the Navy cannot safely continue cleanup until the area is determined to be free of unexploded ammunition. Civilian occupation of the firing range continues to delay the Navy's actions to check for and remove unexploded ammunition. An outline of key events to date is provided in Enclosure 1.

Recent press accounts indicated that a nuclear engineer had found dose rates of up to 37 milliroentgens per hour on the range. The media also reported that this engineer stated that a member of the public could soon exceed a dose limit. If a dose rate of 37 milliroentgens per hour existed, a member of the public could receive a dose in excess of NRC limits. Through the help of your office, we were able to contact the individual who performed the surveys. He told us that the highest dose rate he measured was 37 microroentgens per hour (1000 times lower than the 37 milliroentgens per hour dose rate reported by the press). He also told us that he had not stated that a member of the public was nearing a limit. Based on his survey results, the radiation levels would not cause harm to any exposed individual.

The results of the Navy's assessment of the dose to a member of the public (including the protestors) from the depleted uranium showed it is unlikely to be more than 100 millirem in a year, which is the NRC's limit for doses to members of the public from licensed activities. We have reviewed this assessment and agree with its conclusions. We believe that the Navy's actions to date have been appropriate and that public health is not at risk from the radiation exposures. We also believe that it is in the best interest of public health and safety that the remaining depleted uranium be removed as soon as it can be done safely.

We will continue to monitor the Navy's actions and plan to conduct an independent inspection of their cleanup and corrective actions, including independent measurements to confirm proper cleanup, when such actions can be done safely. Once the Navy completes their corrective actions, we will review the circumstances of the event to determine if NRC enforcement action is appropriate. For your information, Enclosure 2 outlines how the NRC regulates the Navy's use of depleted uranium.

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If you have any questions, please give me a call. We would be happy to provide you any additional information you may need and, if you wish, to personally meet with you to discuss any further concerns that you may have.

Sincerely,

Luis A. Reyes
Regional Administrator

Enclosures: 1. Chronology of Key Events and Actions
2. NRC Regulation of Use of NRC Licensed Material

cc w/encls:
The Honorable Carlos Romero-Barcelo
Resident Commissioner of Puerto Rico
Capitol Hill
2443 Rayburn House Office Building
Washington, DC 20515-5401

The Honorable Adlah "Foncie" Donastorg
Chairman, Committee on Planning and Environmental Protection
Legislature of the Virgin Islands
Capital Building, Charlotte Amalie
St. Thomas, Virgin Islands 00804

Department of the Navy
Naval Radiation Safety Committee
Chief of Naval Operations (N-45)
ATTN: RADM A. Granuzzo
Chairman
Room 636
2211 S. Clark Place
Arlington, VA 22244-5108

CHRONOLOGY OF KEY EVENTS AND ACTIONS

The following is a chronology of key events and actions taken by the Navy and the NRC in response to the firing of depleted uranium armor piercing ammunition on Vieques Island, Puerto Rico.

- On February 19, 1999, two U. S. Marine Corps aircraft fired 263 rounds of depleted uranium ammunition during a training exercise at the Live Impact Area of the Vieques Island firing range. The ammunition consisted of 25 millimeter, armor piercing rounds, containing 148 grams of depleted uranium.

- On March 5, 1999, the Navy's Radiation Safety Committee's Executive Secretary reported the event to the NRC.

- The NRC staff evaluated the incident and determined that depleted uranium ammunition does not pose an immediate safety concern. Because the radioactivity is low, occasional direct exposure of the protestors does not pose a significant radiological hazard.

- The Navy's Radiation Safety Committee reported to the NRC in March 1999, that they had identified this incident as a violation of the requirements of the Navy's radioactive materials permit which specifies that depleted uranium ammunition is to be used strictly during combat or approved tests and are prohibited from peacetime or training use.

- Between March 10 and 19, 1999, a team of Navy health physics personnel located and removed 57 expended rounds of depleted uranium ammunition from the Vieques Island range. Radiological surveys identified some depleted uranium soil contamination which was also removed. The Navy found that most recovered rounds were buried six to eight inches in the soil. The Navy measured a dose rate of 1.2 millirem per hour six inches from a round. Radiation levels at the surface of the rounds remaining on the range, which were not readily accessible, would be higher than the measured level. Recovery activities were discontinued because of the hazards from unexploded ammunition located in areas covered in vegetation where additional surveys and recovery activities need to be performed.

- On April 1, 1999, the Navy provided the NRC with a written initial report of the incident. In that report, the Navy's Radiation Safety Committee provided findings of their preliminary investigation into the cause of the incident, that uncovered a failure by individuals to follow written procedures for the issuance and use of ammunition.

- On June 1, 1999, the Navy provided the NRC with a written follow up report of the incident. In this report, the Navy confirmed their previous findings with respect to the cause of the incident, and also described their planned and implemented corrective actions. In addition to the actual recovery of the depleted uranium ammunition from Vieques, the following additional corrective actions were described: the Marine Corps

issued a naval message to all ammunition activities reemphasizing the prohibition of firing of the 25 millimeter and 120 millimeter depleted uranium rounds for peacetime and training use; applicable Navy and Marine Corps instructions were revised to include the specific use restrictions for depleted uranium ammunition; a checklist was developed and forwarded for use by all depleted uranium ammunition storage facilities; and; the Marine Corps has initiated inclusion of specific depleted uranium information in its Ordnance Occupational (training) Courses.

- On June 2, 1999, Luis A. Reyes, Regional Administrator, NRC Region II, attended a Naval Radiation Safety Committee meeting. During this meeting, the Navy described the circumstances surrounding the expenditure of the depleted uranium ammunition on Vieques. The Navy also described their initial recovery activities, their plans to resume the recovery activities in August 1999, and their corrective actions.

- On June 29, 1999, in a letter to Senator Adlah "Foncie" Donastorg of the Legislature of the Virgin Islands, from then NRC Chairman Shirley Jackson, the NRC committed to provide Senator Donastorg with the results of our independent inspection and review of the Navy's corrective actions. Since the Navy has been unable to continue their recovery activities safely, including the removal of unexploded ammunition, our inspection has not been performed.

- The Navy had planned to resume recovery activities in August 1999, but in the interim, unauthorized individuals began camping on the firing range and, as a result, the team was unable to resume their work to remove the remaining depleted uranium.

- On December 6, 1999, Douglas M. Collins, Director, Division of Nuclear Materials Safety, NRC Region II, attended a Naval Radiation Safety Committee meeting. During this meeting, the Navy discussed preparations for the cleanup. Mr. Collins discussed the need to promptly remove the remaining depleted uranium once the area was safe from potentially unexploded ammunition. Mr. Collins noted that the NRC understood that the Navy could not safely check for or remove unexploded ammunition at the time because of the presence of members of the public in the area.

- On January 19, 2000, the Navy provided the NRC a proposed plan for the recovery of the remaining depleted uranium and cleanup of residual contamination. The NRC is currently reviewing the Navy's plan for compliance with current NRC criteria. If it is determined that this plan meets NRC criteria, the Navy will be informed of this conclusion. If it does not meet our criteria, we will ensure that the plan is revised to meet our criteria. This plan will serve as the basis for the NRC's inspection of the Navy's resumption of the depleted uranium recovery activities. The NRC's inspection will be designed to ensure that the Navy's recovery activities are carried out safely and in accordance with the NRC-accepted plan.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET, SW. SUITE 23T85
ATLANTA, GEORGIA 30303-8931

March 21, 2000

Department of the Navy
Naval Radiation Safety Committee
Chief of Naval Operations (N-45)
ATTN: RDML L. Baucom
Chairman
Room 636
2211 S. Clark Place
Arlington, VA 22244-5108

SUBJECT: REVIEW OF SURVEY WORK PLAN FOR DEPLETED URANIUM (DU) PENETRATORS

Dear Admiral Baucom:

We have completed our review of the Navy's "Survey Work Plan for Depleted Uranium (DU) Penetrators, Vieques Naval Target Range, Live Impact Area, Vieques, Puerto Rico," provided by CDR G. Higgins on January 10, 2000.

In summary, the survey work plan appears sufficient for the Navy to proceed to locate and retrieve the depleted uranium rounds. We have provided four comments (Enclosure 1) that we believe the Navy should address before the survey is conducted. However, it is not necessary for the Navy to submit a response to the NRC. Our technical evaluation is provided in Enclosure 2. After the survey and retrieval of the penetrators, we request that the Navy submit a report documenting the results.

We do not consider the survey work plan to be a decommissioning plan necessary to demonstrate unrestricted release of the site. Any remaining penetrators (i.e., those not located or retrieved under this survey plan) and other residual contamination should be addressed in a future decommissioning plan.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be placed in the NRC Public Document Room.

A/4

Enclosure 1

Should you have any questions concerning this letter, please contact us.

Sincerely,

Mark S. Lesser, Branch Chief
Materials Licensing and Inspection Branch 2
Division of Nuclear Materials Safety

Docket No. 030-29462
License No. 45-23645-01NA

Enclosures: 1. Comments on Survey Work Plan for Vieques Naval Target Range
2. Technical Evaluation Report: U. S. Navy - Vieques Island Review of Survey Work Plan

COMMENTS ON
SURVEY WORK PLAN FOR VIEQUES NAVAL TARGET RANGE

General Comment:

The Navy's Survey Work Plan presents a plan to: 1) perform a survey (it mentions a scoping survey and a final status survey), and 2) retrieve all detected penetrators. Staff from the Office of Nuclear Material Safety and Safeguards concludes that the proposed survey appears sufficient to locate and retrieve the depleted uranium rounds. This Navy Plan does not adequately address the issue of release, either restricted or unrestricted, as defined in Subpart E of 10 CFR Part 20. Therefore, following initial cleanup, the Navy should plan to submit a final decommissioning plan which addresses any unretrieved penetrators and other residual contamination.

Specific comments that the Navy should address prior to initiating cleanup:

1. What actions will the Navy take if a higher-than-background reading occurs and no penetrator is found? To what extent will the Navy investigate the higher-than-background? What will happen to material (e.g., soil, rocks, man-made material) with higher-than-background measurements with no associated penetrator? Will the Navy recover such material?

2. Once the location of the penetrator is found and removal of the penetrator is complete, at what level of contamination will the Navy decontaminate the soil/sand/fragments, if above-background activity is found? Since there is no concentration limit specified for this plan, where will the licensee stop digging or decontaminating the area surrounding the recovered penetrator?

3. In Section 10.5, the second sentence indicates the E-600 is operated in Gross Count Mode for photon energies between 60 and 200 keV. In Section 12.4, it states that the E-600/SPA -3 is calibrated to radiations within the approximate energy range of 60 keV to 2000 keV. The plan should clarify what energy range will be set during the actual survey, 60 - 200 or 60 - 2000 keV.

4. The Navy should consider the criterion for re-surveying an area that exhibits readings above background, as described in section 11.3. The plan should address initiating an investigation when the net count above background exceeds the critical level, rather than the MDA. The critical level in this case is about one half the MDA.

TECHNICAL EVALUATION REPORT
U. S. NAVY - VIEQUES ISLAND
REVIEW OF SURVEY WORK PLAN

INTRODUCTION

The U.S. Navy notified the U.S. Nuclear Regulatory Commission (NRC) on March 5, 1999, of an event involving depleted uranium (DU) ammunition. The survey work plan indicates that during a training exercise on February 19, 1999, two U.S. Marine Corps aircraft expended 263 DU rounds at the Vieques Island, Puerto Rico, North Convoy Site. The Navy indicated that a team of Navy health physicists was deployed between March 10 and 19, 1999, and recovered 57 DU rounds. Only a portion of the site was investigated at that time because of unexploded conventional ordinance and dense vegetation. The Navy plans to recover all detectable DU penetrators and conduct a final status survey.

The Navy submitted a Survey Work Plan in December of 1999. The purpose of the plan is to conduct a 100 percent survey of the area and remove all detectable DU rounds. This plan provides the following: (1) a history of the event, (2) a site description, (3) a summary of previous radiological investigations, (4) a summary of health effects associated with DU, and (5) a description of the planned survey methods.

DISCUSSION

This review is based on the information in the survey work plan and is divided into two areas: (1) detection of the DU, and (2) survey methods. In general, the survey work plan did not provide complete information. Therefore, we performed an independent analysis to support our review.

1. Detection of the DU Rounds

Summary of Information Submitted

Section 5 of the survey work plan describes the previous radiological investigation. The Navy used 2-inch x 2-inch sodium iodide (NaI) and pancake Geiger-Mueller (GM) detectors. The NaI detector was used for scanning. During this investigation, the Navy recovered 57 rounds, most of which were completely intact. The rounds were encountered at a spacing of 10 to 20 feet along the lines of fire, and about twenty percent of the rounds were on the surface. For rounds that were beneath the ground, the report estimates the average depth of six to eight inches, with a maximum depth of 18 inches. The work plan notes that "only a few holes exhibited residual contamination after the penetrator was removed. In these cases, part of the penetrator had fractured."

The survey area will consist of approximately 10 acres (figure 3 of the survey work plan). The plan indicates that the actual affected area may be in the range of 1.5 acres, because the DU rounds are expected to be located along two firing lines. Two soil types

(clay and sand) are expected to be encountered in the survey area. The background was estimated as 8,000 cpm and 3,000 cpm for the clay and sand soils, respectively. The survey work plan provides the following equation for the scanning minimal detectable activity (MDA):

$$L_d = 3 + 4.65\sqrt{B_i}\,\frac{60}{i}$$

where

L_d	net response level, in counts, that can be detected with a survey meter with a fixed level certainty
B_i	number of background counts in the scan interval
i	integrated scan interval in seconds

Actual MDAs are not reported. The survey work plan estimates a field of view of the detector of 5 inches in diameter for a penetrator buried at 9 inches. However, the basis for this estimate is not provided.

Staff Evaluation

DU consists of 99.8% uranium-238 (U-238), 0.2% uranium-235 (U-235), and 0.001% uranium-234 (U-234) [Ref 2]. The primary radionuclides that contribute to dose from DU are U-238 and its daughters with short half-lives[1], thorium-234 (Th-234), and protactinium-234m (Pa-234m). The minor amounts of uranium-235 (U-235) and lesser amounts of uranium-234 (U-234) do not contribute significantly to dose. Because the daughters of U-238 have significantly shorter half-lives, they are in secular equilibrium with the parent U-238. That is the U-238, Th-234, and Pa-234m are present at the same activity. Each round contains 148 grams of DU. Using a specific activity for DU of 4.3 x 10^{-7} Curies per grams (Ci/g) reported in U.S. Army Center for Health Promotion and Preventive Medicine report, "Radiological Sources of Potential Exposure and/or Contamination, TG-238." [Ref 2], each round contains 6.36 x 10^{-5} Ci total initial activity. U-238, U-235 and U-234 emit several alpha particles and several low energy gamma rays each. Th-234 emits four beta particles (average energies range from 19.5 to 50.6 keV) and several low-energy gamma rays (63.3 to 112.8 keV). Pa-234m emits three beta particles (average energies range from 410.2 to 825.4 keV) and several gamma rays (766.4 to 1001.0 keV). [Ref 3] The significance of these emissions relative to detection is discussed in the following section.

MARSSIM [Ref 1] provides detailed guidance for planning, implementing, and evaluating environmental and facility radiological surveys. These surveys involve sampling at discrete locations and performing non-parametric statistical tests to evaluate the data. Scanning is also performed to evaluate elevated measurements. MARSSIM is typically applied to residual contaminated areas (soil or building surface). Because the contamination at this site consists of predominately elevated areas (hot spots) that have a very small area, the statistical tests in MARSSIM are not strictly applicable.

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[1]The time required for the activity to reduced by one half.

The survey work plan presented an equation for the detection limit (L_d), but did not provide values for L_d. The detection limit is typically associated with sample counting. The expression for stating detection capabilities would be to use a minimum detectable concentration (MDC) for static measurements, or a scan-MDC for scanning measurements. The scan-MDC represents the minimum concentration above background that the scan survey instrument can distinguish from background. Methods for calculating the scan-MDC are presented in NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions" [Ref 4]. Specifically the minimum detectable count rate (MDCR) in counts per minute can be calculated using the following equation.

$$MDCR = d' * \sqrt{b_i} * \frac{60}{i}$$

where

b_i	background counts in the observation interval
d'	index of sensitivity
i	observation interval (in seconds), based on the scan speed and areal extent of the contamination

The background count rate is 8,000 cpm for the clay soil. If we assume a one second observation interval and that the index of sensitivity is one, b_i is 133 counts and the MDCR is 692 counts per minute. For the sand soil, the background count rate is 3,000 cpm. If we also assume a one second observation interval and that the index of sensitivity is one, b_i is 50 counts and the MDCR is 424 counts per minute. These counts per minute are above background. It is not clear from the information provided how the background count rates were estimated (e.g., detector type, height above the ground). Background count rates should be determined using the survey instruments. Actual background count rates should be used to calculate the instrument MDCR. We have assumed that the reported background count rates are representative for purposes of our analyses.

The MDCR is used to calculate the minimal detectable concentration of a scan survey (scan-MDC) in disintegrations per minute (dpm) using the following equation.

$$Scan - MDC = \frac{MDCR}{\sqrt{p \varepsilon_i \varepsilon_s}}$$

where

p	efficiency of the surveyor
ε_i	efficiency of the instrument
ε_s	efficiency of the contaminated source

Because all the data are being recorded, the surveyor efficiency is one. The instrument efficiency is estimated by the Navy as 10 percent. The contaminated source efficiency is approximately 2 percent (i.e., 50 percent of the contamination will be emitted upward toward the detector and only 4 percent of the emissions are gammas). The scan-MDC

for clay is calculated to be 3.46×10^5 dpm, and the scan-MDC for sand is calculated to be 2.12×10^5 dpm. As discussed above, the activity of one round is 6.36×10^{-5} Ci or 1.4×10^8 dpm. Based on this analysis and the data in figure 8 of the survey work plan, we conclude that the system will be able to detect rounds located on the surface.

Most of the gamma rays emitted by the DU have low energies. If the DU round is located beneath the ground surface, these gamma rays will be attenuated by the soil. To evaluate ability of the Eberline SPA-3 to detect the DU round beneath the ground surface, we used the information in NUREG-1507 [Ref 4]. The computer code SuperShield, version 1, was used to quantify the attenuation of the gamma rays. The gamma ray energies, flux (gamma rays emitted per second) and geometry of the shielding material (i.e., soil and air) are entered. The code calculates the exposure rate in roentgen per hour at a hypothetical detector. The spectrum of gamma ray energies and percent yield[2] were obtained from "Radioactive Decay Data Tables" [Ref 3]. The flux for each gamma ray was obtained by calculating the activity for each isotope and multiplying by the percent yield. The total initial activity of the DU round was calculated to be 1.4×10^8 dpm. As discussed above, the short-lived daughters of U-238 would also be present at this activity. Although U-235 is present at 1.39×10^6 dpm, it does emit a large number of weak gamma rays. Several of the gamma rays with small percent yields were combined with other gamma rays having similar energies. The gamma ray spectrum used in the analysis is summarized in Table 1.

Table 1. Gamma ray spectrum

Isotope	Gamma Ray Energy (keV)	Activity (dpm)	Percent Yield (%)	Emissions (dpm)	Emissions (dps)
U-238	66.4	1.4×10^3	0.1	1.4×10^5	2.3×10^3
U-235	109	1.4×10^6	1.6	2.3×10^3	3.8×10^1
	143.6	1.4×10^6	10.7	1.5×10^5	2.5×10^3
	163.3	1.4×10^6	4.7	6.6×10^4	1.1×10^3
	185	1.4×10^6	54.4	7.7×10^5	1.3×10^4
	202	1.4×10^6	6.39	9.0×10^4	1.5×10^3
Th-234	63.3	1.4×10^8	3.8	5.3×10^6	8.8×10^4
	92.6	1.4×10^8	5.4	7.6×10^6	1.4×10^5
Pa-234m	1000	1.4×10^8	0.6	8.4×10^5	1.4×10^4

The dose rate was calculated for DU rounds buried both in clay and sand at depths of 6, 9, 12,

[2]Percent yield is the fraction of emissions that produce a gamma ray at a specific energy.

18, and 24 inches. Both soil layers were modeled as concrete in the shielding code. For the clay soils a bulk density of 1.8 g/cm^3 was used, and for the sand soils a bulk density of 1.5 g/cm^3 was used. Because of the typically higher shear strength of the clay, it is anticipated that rounds would be buried deeper in the sand soil. For each of the simulations, a depth specific conversion factor was developed to convert μR/hr to cpm. Table 6.3 of NUREG-1507 provides an energy dependent conversion factor for a 2-inch by 2-inch NaI detector. The conversion factors were determined by multiplying the dose rate for each gamma ray by the appropriate conversion factor from Table 6.3 and summing these products to obtain a depth specific conversion factor. As would be expected, the lower energy gamma rays are attenuated by the soil, and the depth specific conversion factor decreases with depth. Table 2 summaries the results of the SuperShield analyses.

Table 2. Summary of SuperShield Analyses

	CLAY			SAND		
Depth (in)	Exposure Rate (μR/hr)	Conv. Factor (cpm/μR/hr)	cpm	Exposure Rate (μR/hr)	Conv. Factor (cpm/μR/hr)	cpm
6	2.28	5,880	13,400	3.03	10,093	30,600
9	0.658	816	537	0.935	1,625	1,520
12	0.227	178	40.3	0.351	362.5	127
18	0.032	18.5	0.6	0.063	39.8	2.52
24	0.005	2.9	0.014	0.012	6.9	0.01

Comparing the estimated count rate at depth with the MDCR (i.e., 692 cpm for clay and 424 cpm for sand), we concluded that penetrators buried in either clay or sand will likely not be detected at depths greater than about 10 inches. If the penetrators are fragmented, the depth of detection will vary.

2. Survey Methods

Summary of Information Submitted

The proposed methods for conducting the recovery survey are presented in section 10 of the survey work plan. Three Eberline SPA-3 (2-inch x 2-inch) detectors connected to an Eberline E-600 multi-purpose digital survey instrument will be used. The survey instrument will be operated in gross count mode. The detectors will be mounted on a pushcart. The system will be calibrated with radiation within the approximate energy range of 60 keV to 2,000 keV with an accuracy of approximately 10 percent. The data will be transmitted using the NAVTRACK 2000 system. This system incorporates differential global positioning that is accurate to within 6 to 18 inches. Data will be recorded for each detector every second. A scan rate of 18 inches per second is proposed. Daily checks of the detectors and E-600 will be performed. In addition, the

NAVTRACK 2000 operation will be checked daily to a quality control point at the start and end of each survey.

Background radiation levels will be established on-site from readings in the actual survey area. Because the contamination consists of discrete sources and is not uniformly distributed, the Navy proposes to use the survey area itself as the background area. Areas that exhibit readings above background will be re-surveyed with either hand-held instruments or the NAVTRACK system.

The survey work plan provides a health and safety plan, and procedures for detector calibration, gamma scintillation operation, and backpack, radcart and PC/master controller assembly. The plan also discusses the hazard from unexploded ordnance.

The data will be analyzed using the computer software available with the NAVTRACK system. Statistical information (high, low, mean, and standard deviation) will be calculated. A graphical review of the data will be performed using posting plots/maps and frequency plots/maps. An example of the system graphical output was provided for three penetrators located on the surface (Figure 8 of the survey work plan).

Staff Evaluation

The Navy should consider clarifying in the survey work plan the extent of a survey of an area after the penetrator is removed. The survey and remediation of the immediate area around a recovered DU round should be better delineated. In addition, information on the hand-held instruments was not provided in the survey work plan. Consideration should be given to using an instrument that will be more sensitive than the Eberline SPA-3 to more easily detect DU rounds at depths deeper than 10 inches. The MDC for the hand-held instrument should be calculated and compared with the information in Table 2.

The survey work plan does not specifically address radiation protection other than estimating the dose to range workers of approximately 0 mrem per year. This survey and recovery work should be conducted under an appropriate radiation safety program approved by the Navy. This would include personnel dosimetry, monitoring, and contamination control. Protective measures, such as wearing gloves, using tongs, and limiting handling time, should be implemented. In addition, acceptable methods for storing the DU rounds that are collected also should be indicated.

The survey work plan notes that basic statistical quantities will be calculated. It is not clear from the information provided what these quantities are or how they will be used in the decision making process. In addition, it is not clear to what extent quality assurance will be provided for the radiofrequency transmission of data, to verify that data is not corrupted during transmission.

CONCLUSIONS AND COMMENTS

The proposed detection system and survey methods appear to be sufficient to detect DU rounds on the surface. While MARSSIM [Ref 1] is not strictly applicable to this type of survey, if the Navy desires to use the results for unrestricted release, it should consider the framework of the MARSSIM process to the extent practical. This would include consideration of the development of data quality objectives, estimation of MDC, and interpretation of survey data. Based on certain assumptions, we estimate that rounds buried deep (about ten inches or more) will be difficult to detect. We recommend that the Navy consider conducting, prior to beginning the actual survey, a "mock" survey at the site. The purpose of the "mock" survey would be to demonstrate at what depth the scanning equipment can detect the DU rounds. This "mock" survey could consist of burying several intact and partial DU rounds and various depths and scanning the area to determine the system response. Information from the "mock" survey can be used to more accurately estimate the detector efficiency, MDCR, and response for the NAVTRACK system and hand-held instruments.

In summary, although our review revealed some technical concerns, we conclude that survey work plan is adequate to detect the DU rounds. Because our analysis relied on several assumptions, it is advisable that Region II staff be present during the "mock" survey. In addition, Region II staff should be present at the beginning of the actual survey and periodically afterwards, if deemed necessary, to evaluate the effectiveness of the survey. After the survey is completed and the actual number of rounds that remain has been determined, the Navy should consider submitting a report documenting the results. Moreover, rounds not retrieved should be addressed in any decommissioning plan. It is advisable that the NAVY meet with NMSS and Region II staff to discuss the scope and details of a decommissioning plan before making a formal submittal. This will assist in streamlining the review by reducing the number of clarification questions that may result. If all the DU rounds are recovered, the site would be considered acceptable for unrestricted release in accordance with Subpart E and no additional submittal would be required.

REFERENCES

1. USNRC, " Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," NUREG-1575, U.S. Nuclear Regulatory Commission, December 1997.

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3. Kocher, David C., "Radioactive Decay Data Tables, A Handbook of Decay Data for Application to Radiation Dosimetry and Radiological Assessments," U.S. Department of Energy, April 1981.

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SURVEY WORK PLAN

For

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

Prepared By

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

December 1999

Enclosure 2

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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
DU	depleted uranium
E-6OO	Eberline Model E-600 Survey Meter
EOD	Explosive Ordnance Disposal
EPM	Environmental Project Manager
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(Tl)	sodium iodide with thallium (crystal)
NAVSEADET RASO	Naval Sea Systems Command Detachment, Radiological Affairs Support Office
NIST	National Institute of Standards and Technology
PCB	polychlorinated biphenyl
pCi	picocurie
pCi/g	picocurie per gram
POC	point of contact
RF	radiofrequency
TEDE	total effective dose equivalent
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 due to logistic constraints.

Navy health physicists plan to return to the affected site and recover all detectable DU penetrators and conduct a final status survey. The final status survey will consist of a 100% high-density scan of the affected area using sodium iodide detectors. All areas that are distinguishable from background will be investigated. At a 95% confidence level, the scanning detection system can detect a 25-mm DU round, consisting of 148 grams of DU at a depth of 9 inches in soil.

The Navy must contend with several challenges before and during surveys of the North Convoy Site. Most importantly, the Navy 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 final status survey is 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 100% survey of the affected area and remove all detectable DU penetrators. The survey equipment combines a commercial Differential Global Positioning System (DGPS) and high-density data collection/management system with 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 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 patches of mesquite vegetation and the soil is also composed of a mixture of sand and small 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). It is optimistic that the actual lines-of-fire can be identified and then the actual affected area could be reduced to approximately 1.5 acres.

5.0 PREVIOUS RADIOLOGICAL INVESTIGATIONS

A team lead by Navy health physicists was dispatched to Vieques between 10 and 19 March 1999, 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 distinct paths radiating from the targets (starting at two armored tanks) in a northern direction (see Figure 3). Buried penetrators were visually located by the presence of a depression, hole, or divot in the soil and confirmed radiologically using a 2 inch by 2 inch sodium iodide and pancake G-M detectors.

The team recovered a total of 57 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). One penetrator was buried up to 18 inches in very loose soil. Only 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 Convey 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 (>99.7% 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 the trespassers occupying the Live Impact Area (LIA)[1]. Although civilian trespassers have unimpeded access to the entire Atlantic Fleet Weapons Training Facility on Vieques, they have seldom been observed for extended periods on the LIA but have been seen transiting the access perimeter road.

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 intact or in large 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 survey conducted in March 1999, 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 have to be removed or cut to a height not to exceed four inches prior to the survey to allow survey teams full access. Because of the unexploded ordnance, access to the range requires an Explosive Ordnance Disposal (EOD) team escort. 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. A portable gasoline generator will supply electrical power.

9.3 Personnel

At a minimum the technical assist team will consist of a Team Leader (Navy health physicist), a Radiological Environmental Project Manager (EPM) from NAVSEADET RASO, two explosive ordnance disposal (EOD) personnel, and two AFWTF Inner Range personnel. Commanding Officer AFWTF, will provide local logistical support, NAVSEADET RASO is the technical point of contact (POC) for the team, and Chief of Naval Operations (N455) is the Naval Radiation Safety Committee's POC for the team.

10.0 RADIOLOGICAL SCAN SURVEY EQUIPMENT

10.1 Introduction

As shown in Figure 6, the survey equipment combines a commercial Differential Global Positioning System (DGPS) and data management system with commercial radiation detection equipment. The system records a detector's physical location to the data acquired during scan surveys. The system produces real-time positioning for the survey data that is collected every second. The system manages all the data and provides posting plots of the area surveyed.

10.2 Geographic Positioning

The positioning system is based on a commercial Differential Global Positioning System. The software with the system identifies the location of the data collection point and assigns relative coordinates to the data for later analysis. The positioning system is accurate to within 6 to 18 inches.

10.3 Data Collection

The NAVTRACK 2200 system is able to transmit data from up to six detectors every second. The NAVTRACK data pack receives detector input and transmits the data via radiofrequency modem to a receiver connected to a microcomputer, which records the data and its position. The system records 3600 data points per hour per detector.

10.4 Detectors

Eberline SPA-3, 2-inch by 2-inch sodium iodide detectors will be used for the survey. The detector will be calibrated specifically for DU. The detector's field of view was mapped by measuring penetrators on the surface and buried in soil. In the field, the measurement system was capable of detecting the detection limit (L_D) of minimal detectable activity (MDA), net counts above background, as defined in Section 10.5 below.

The detector field of view for a 148 gram DU penetrator, buried in clay and sand soils, with background count rates of approximately 8000 cpm and 3000 cpm, respectively, is approximately a hemispherical volume of soil about 5 inches in diameter and 9 inches deep. The actual field of view in the soil at Vieques will be verified on-site prior to the survey. When terrain features permit, multiple detectors will be mounted on a pushcart, similar to one shown in Figure 6 to survey a wider area at one time.

10.5 Multi-Purpose Digital Survey Instrument

The sodium iodide detectors are connected to the Eberline E-600 multi-purpose digital survey instrument. The E-600s are operated in the Gross count mode for photon energies between 60 and 200 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 each detector is exported to the NAVTRACK system.

10.6 Scanning Minimal Detectable Activity (MDA)

The measurement system's scanning MDA, the detection limit (L_D), is calculated using the following formula.

$$L_D = k^2 + k\sqrt{2B_i} \times \frac{60}{i}$$

$$L_D = 3 + 4.65\sqrt{B_i} \times \frac{60}{i}$$

Where

- L_D: the net response level, in counts, that can be detected with a survey meter with a fixed level of certainty
- K: Poisson probability at a 95% confidence level (1.645)
- B: number of background counts in the scan interval
- i: integrated scan interval (seconds)
- C: 60/i used to convert to cpm

10.7 Data Analysis

The data analysis software can provide real time screen displays and printouts in real time of the data being collected. The data can be color coded to different thresholds specified by the operator. Statistical information (high, low, mean, and standard deviation) can be calculated for the entire survey file or operator specified blocks. The software can also apply gridding and calculate the average values for each grid and display them by operator specified thresholds. Figure 7 shows a track map of a small scanned area. This area has several different surface

media (asphalt, clay soil, grass over clay soil, and sand) and three DU penetrators located on the surface. The track map has color-coded thresholds based on the count rate. The red dots show the locations of the DU penetrators. Figure 8 shows a stack map (combined contour and surface maps) of the same scan data. These types of graphical representations of the scan data, in conjunction with statistical tests will be used to detect the location of DU penetrators on Vieques.

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

11.0 RADIOLOGICAL SCAN SURVEY

11.1 Radiological Survey

Using the above survey system and a forward scanning speed of 18 inches per second a high density scan survey will be conducted over the area identified in Figure 3. This area covers approximately 10 acres. Including a scoping survey and the final status survey, approximately 1,000,000 one-second-scan data points will be taken. This equates to approximately five data points per square foot.

The Navy is optimist that the survey area can be further reduced in size if the exact lines-of-fire can be identified. The survey would then be concentrated on precise paths and potentially reduce the survey area from 10 acres to approximately 1.5 acres.

11.2 Background Determination

The background radiation level(s) will be established on-site 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 this local area background.

11.3 Potentially Contaminated Areas

Areas that exhibit readings above background (net counts above background that exceed the MDA) will be re-surveyed with either hand-held instruments or the NAVTRACK system. If the re-survey fails to produce consistent high readings the lack of reproducibility will be noted in the survey.report and false data will be excluded from analysis. Abnormal low readings, which are usually caused by timing fluctuations of the instruments, will also be excluded from the correlated data files.

12.0 QUALITY ASSURANCE PLAN

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 Team Leader will ensure that personnel involved in this project meet the necessary training requirements. An environmental project manager (EPM) from NAVSEADET RASO will control data collection and with the Team Leader analyze the data.

12.3 Training

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.

Personnel operating the NAVTRACK 2200 system will have either completed training by CHEMRAD, the manufacturer of the system, or be under the supervision of someone that has completed the CHEMRAD training.

Personnel operating the survey detection equipment will have either completed training by NAVSEADET RASO or be under the supervision of someone that has completed the training.

12.4 Design of Data Collection Operations

12.4.1 Equipment

The SPA-3 and E-600 systems will be calibrated using the manufacturer's calibration protocol to a National Institute of Standards and Technology (NIST) traceable source at the Radiological Affairs Support Office. The E-600/SPA-3 is calibrated to detect gamma radiation within the approximate energy range of 60 keV to 2000 keV with an accuracy of ±10%. Daily source checks will be performed to verify proper operation of the detectors and E-600s. In addition, as part of the NAVTRACK 2200 operation, a Quality Control Point (DGPS point) is taken at the start of each survey and a second point is taken at the same location at the end of the survey to verify proper operation of the tracking equipment.

12.4.2 Data Collection

Data collection will be performed in accordance with CHEMRAD specifications. CHEMRAD is the manufacturer of the NAVTRACK equipment.

12.4.3 Database Security

The NAVTRACK 2200 system is designed to produce tamper-resistant survey files (*.sva). These files cannot be used for data analysis and data reduction. The system also produces correlated data files (*.cdf) that can be used for data analysis and reduction. All of the raw data collected during the survey will be copied to floppy discs and safeguarded by the EPM. Upon return to NAVSEADET RASO, the files will be transferred to an access-controlled computer.

12.4.4 Data Review

The Team Leader will review data at the end of each survey to determine the validity of the results and adequate coverage of the survey area.

12.5 Data Assessment

Basic statistical quantities will be calculated for the data in order to identify patterns, relationships and any type anomaly. Graphical review of the data will be performed using posting plots/maps and frequency plots/maps. This will identify any small heterogeneities in the survey unit and will serve as a visual representation of the symmetry in the data.

13.0 HEALTH AND SAFETY PLAN

13.1 Introduction

Federal laws, as well as Navy policy, make the safety and health of our members the first consideration in operations. Good safety and health practices must be a part of our operation, and every member's responsibility. Work conditions will be reviewed to identify hazards. Appropriate actions will be taken to ensure a safe workplace. No member will be required to work at a job known to be unsafe or dangerous to his or her health.

13.2 Safety First Priority

The personal safety and health of each member is of primary importance. Prevention of occupationally induced injuries and illnesses will be given precedence over operating productivity. The Team Leader will provide all mechanical and physical protection required for personal safety and health. Workers bear primary responsibility for working safely.

13.3 Individual Cooperation Necessary

The Navy will maintain a safety and health program conforming to the best practices of our field. To be successful, such a program must embody proper attitudes towards injury and illness prevention on the part of supervisors and members. It requires the cooperation in all safety and health matters, not only of the employer and member, but between the member and all co-workers. Only through such a cooperative effort can a safety program in the best interest of all be established and preserved. Safety is no accident; think safety and the job will be safer.

13.4 Safety Rules for All Team Members

– All members shall follow the safe practices contained in this plan and communicated on the job. Members are responsible to report all unsafe conditions or practices to the proper authority, including the Team Leader. Safety considerations will be included in job pre-briefs. Members will observe safe practice rules and instructions relating to the efficient handling of the job. Know and obey safe practice rules. Know that disciplinary action may result from a violation of the safety rules.

– The Team Leader/supervisors shall be responsible for implementing these policies by insisting that members observe and obey all rules and regulations necessary to maintain a safe work place and safe work habits and practices.

– Suitable clothing and footwear must be worn at all times. Do not wear shoes with thin or torn soles. Equipment (hard-hats, respirators, and eye protection) will be worn whenever needed.

– There will be no consumption of liquor or beer on the job. Anyone under the influence of intoxicating liquor or drugs, including prescription drugs that might impair motor skills and judgment, shall not be allowed on the job.

– Horseplay, scuffling, and other acts which tend to have an adverse influence on safety or well being of other members are prohibited. Do not throw things, especially material and equipment. Caution fellow workers when they perform unsafe acts.

– Work shall be well planned and supervised to avoid injuries in the handling of heavy materials and while using equipment. When lifting heavy objects, use the large muscles of the leg instead of the smaller muscles of the back

– No one shall be permitted to work while the member's ability or alertness is so impaired by fatigue, illness, or other causes that might expose the member or others to injury. No one will be allowed to work when a person's physical condition, may impair judgment and safety.

– Good housekeeping must be practiced at all times in the work area. Dispose of all waste properly and carefully.

– Members should be alert to see that protective devices are in proper places and adjusted, and shall report deficiencies promptly to supervisors. Report all unsafe conditions or equipment to your supervisor immediately.

– Members shall not handle or tamper with any electrical equipment, machinery, or air or water lines in a manner not within the scope of their duties, unless they have received specific instructions. Don't tamper with anything you do not understand.

– All injuries will be reported to the supervisor so that arrangements can be made for medical or first aid treatment. Report all injuries immediately, no matter how slight the injury may be.

– Don't take chances. Ask questions when there is any doubt concerning safety.

– Fire hazards are to be minimized. Smoking is not allowed on the site, except in designated areas.

13.5 Safety and Health Training

Training is one of the most important elements of any injury and illness prevention program. Training is required for both supervisors and members alike. The content of each training session will vary, but each session will attempt to teach: (a) the individual responsibility to ensure a safe work place and illness prevention program depends on the actions of individual members; (b) when personal protective equipment is required or necessary and how to use and maintain the equipment in good condition; and (c) what to do in case of emergencies occurring in the workplace.

13.6 Communication

The Team Leader/Supervisors shall remind team members their obligation to safety and ensure that members are familiar with the elements of the safety program. A copy of this plan will be maintained in the work area. Concentrated efforts shall produce safe working conditions and result in efficient, productive operations. Safeguarding the health and welfare of our members cannot be stressed too strongly. Accident prevention is everyone's responsibility.

13.7 Hazard Identification & Abatement

EOD and Range personnel assigned to the team will review areas/sites prior to commencement of work and periodically. The review will identify any potential hazards and methods to abate.

13.8 Accident Investigation

Whenever there is an accident resulting in an injury a critique will be held to identify the root, contributing causes and corrective actions. Purpose of the critique is to identify root causes and corrective actions, and is independent of disciplinary actions.

13.9 Records

All training records and accident investigation will be maintained.

14.0 CALIBRATION OF DETECTORS FOR NAVTRACK OPERATION

14.1 Purpose

The purpose of this procedure is to ensure that the radiation detection equipment used with the NAVTRACK system is calibrated.

14.2 References

Eberline Model E-600 Portable Radiation Monitor Technical Manual

14.3 Materials

- E-600 survey meters
- Computer with Eberlines E-600 Interface program (ver 210) installed
- E-600 interface data cable
- E-600 probe cable
- Printer
- Eberline SPA-3, 2"x2" NaI(Tl) detectors
- Smart packs. One for each detector where they are not already an integral part of the detectors to be used
- NIST traceable DU calibration standard
- Ruler
- Tape, planchets or whatever else is required to hold the geometry constant between the detectors and the standard
- Calibration work sheet, one for each detector

14.4 Responsibility

NAVSEADET RASO is responsible for the proper calibration of the instruments.

14.5 Protocol

14.5.1 Preparation

a. Turn each of the E-600's on to the "check" position and observe the display face. The display should provide the following information:

1) Scale - across top

2) Probe Fail - lower left corner

3) Battery strength - lower right corner

b. Turn each E-600 off. Replace the batteries in any ratemeter which are at less than 70% for battery strength. Do this by removing cover on bottom of case to gain access to the batteries. The E-600 uses three "C" cells.

c. Hook-up

1) Connect the E-600 to the computer via the interface cable.

2) Connect the detector to the E-600 via the probe cable. Connect any required smart packs prior to this step.

3) Connect the printer to the computer.

4) Turn the computer and the printer ON.

5) Turn the E-600 switch to the CHECK position.

14.5.2 Calibration

a. Double click on the E-600 icon.

b. Double click on INSTRUMENT PARAMS.

1) Set instrument parameters to desired characteristics. Recommend setting the STAR KEY to start scaler.

2) After setting parameters, click on OK. At this time you will be asked for a password: Enter EBERLINE.

c. Double click on SMART PROBE.

1) Using the manual confirm parameters for the detector being used.

2) Click on OK.

d. Double click on SMART CHANNEL.

1) Confirm that the CHANNEL TYPE and UNITS are as desired for each channel. Confirm that all other parameters are set in accordance with the manual.

2) Click on OK.

e. At the top of the E-600 window, click on CALIBRATE.

1) On the drop down menu, click on RUN PLATEAU.

2) On the VOLTAGE PLATEAU screen set the desired parameters. This will vary with type of detector and source to detector geometry. Name the graph and file.

3) Click on start. It will take 30 seconds for the HV to stabilize. Watch the plot develop, if the continuous discharge region is reached before the end of the selected voltage range, stop the plot by clicking on DONE and answering following messages.

4) Determine the proper HV for the detector by using the HV value that occurs halfway between the knee of the plateau and the start of the continuous discharge region.

5) Set the HV by click on the arrows on the graph until the vertical line is at the desired point. Click on the SET HV button.

14.5.3 Efficiency

(Matching of Survey Equipment: While it is allowable for most survey instruments to be calibrated to ± 20%, the precision between the instruments needs to be much tighter. Otherwise problems are perceived where none exist, especially since one second counting times are used.)

a. Select the appropriate geometry and NIST traceable standard for the detector being used. This will normally be:

b. Gamma - Point source standard at a distance of eight inches from the face of the detector, centered.

14.6 Calibration Forms

14.6.1 Printing the Calibration Graph for each Detector

a. Click on DISPLAY GRAPH.

b. Double click on file to be displayed.

c. Click on FILE.

d. Click on PRINT GRAPH.

14.6.2 Printing the Calibration Report for each Detector

a. Click on PRINT CALIBRATION REPORT in the CALIBRATE pull-down menu.

b. Enter the isotope and activity of the source used to calibrate the detector on the calibration report.

15.0 GAMMA SCINTILLATION OPERATION

15.1 Purpose

This procedure describes the use of the Eberline E-600 and its associated gamma scintillation detectors.

15.2 Reference

Eberline Technical Manual. E -600 Portable Radiation Monitor

15.2.1 Figures

a. E-600 and associated scintillometers (Figures 6 and 7)

b. Survey Path (Figure 3)

15.2.2 Materials

a. Eberline E-600

b. Eberline Scintillation Probe SPA-3

c. Probe Cable

d. Computer Interface Cable

e. Type C batteries

15.2.3 Responsibility

a. TEAM LEADER: Is responsible to ensure that enough instruments are available for fieldwork and that they meet the calibration specifications.

b. TEAM MEMBERS: Team members prevent loss of or damage to instruments and clean and decontaminate instruments after field use.

c. NAVSEADET RASO: Is responsible for the proper calibration of the instruments.

15.2.4 Frequency

a. Calibration of the instruments will be performed on a yearly basis.

b. Calibration checks will be performed, at a minimum, daily prior to use.

15.2.5 Protocol

a. Remove the E-600 and corresponding probe, SPA-3, from storage in the survey vehicle and visually check for physical damage. If physically damaged, do not use.

b. Connect probe to ratemeter. Annotate the serial numbers.

c. Turn instrument selector switch to "Check"

d. Insure that the display indicates that the instrument is set for "γ" and the serial number of the probe is correct. If the display indicates any anomaly replace the probe or the ratemeter.

e. Insure that the batteries are over 70% charged. If not, replace.

f. Connect the ratemeter via the computer interface cable to the NAVTRACK serial expansion or the data pack on the Radcart or the Backpack.

15.2.6 Calibration Check

a. Perform a calibration check at the beginning of each survey day.

b. After a quality check has been performed with the NAVTRACK software the calibration check is performed using the "Bias Point" command.

c. Place the check source under the probe or between probes if using an array of probes. Allow for the collection of data.

d. Print the "survey statistics" from the NAVTRACK survey program.

e. Subtract the "Bias Point" readings from the "Quality Point" readings from the same coordinates. This will produce the net cpm necessary to confirm the calibration check.

15.2.7 Survey

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

b. The Audio response of the ratemeter may be used to identify areas of elevated readings as the survey progresses. However, the surveyor should concentrate on maintaining a straight path.

c. When the survey is complete progress to an acceptable position to record a "Quality Point."

d. When given the signal that data collection is complete, turn the instruments off.

16.0 BACKPACK, RADCART AND PC/MASTER CONTROLLER ASSEMBLY

16.1 Purpose

To provide assembly instructions for the Backpack and Radcart for use with the NAVTRACK system.

16.2 Reference

NAVTRACK Users Manual, Chemrad Tennessee Corp, Oak Ridge, TN.

16.3 Materials

- 12 V Battery
- Backpack Frame
- Coaxial Cables
- Data Pack
- DGPS Rover Antenna
- Eberline E-600s
- Handheld Terminal
- Instrument Rack
- Masts
- NaI Detectors
- Radiofrequency (RF) Modems
- Serial Expansion Box
- Velcro Straps

16.4 Responsibility

It is the responsibility of the team leader to insure that the Backpack and Radcart reach their destination. It is the responsibility of the RASO EPM to assemble the Backpack and Radcart and ensure they are working properly.

16.5 Protocol

16.5.1 Backpack

a. Assemble the Instrument Rack according to the instructions provided by the manufacturer. Attach the Instrument Rack to the backpack frame.

b. Attach the Data Pack and Serial Expansion Box to the Instrument Rack.

c. Attach the E-600s to the Instrument Rack. Secure with velcro straps.

d. Attach the DGPS and Master Controller RF modems to their masts. Attach the masts to the backpack, ensuring one of the modems is at least 12 inches higher than the other.

e. Connect the modem cables to the Data Pack. Connect the computer interface cables between the E-600s and the Serial Expansion Box. Connect the cable between the Serial Expansion Box and the Data Pack. Ensure the Data Pack power switch is OFF and connect the power cable to the 12-volt battery (on Radcart).

16.5.2 Radcart

a. Assemble the Radcart frame (base, wheels, handle, and antenna post).

b. Connect the antenna cable to the DGPS Rover antenna and attach the antenna to the antenna post.

c. Install the NaI detectors in the holders. Place the end of the detector not more than 4 inches above the ground. Tighten the mounting set screws.

d. Attach applicable coaxial cables.

e. Connect the detector cable between the E-600s and the detectors on the Radcart.

16.5.3 PC/Master Controller

a. Attach an antenna to the Master Controller.

b. Connect the Master Controller to the computer with a serial cable.

c. Connect the Master Controller to a 12 V DC power source.

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Figure 1. Live Impact Area on Island of Vieques.

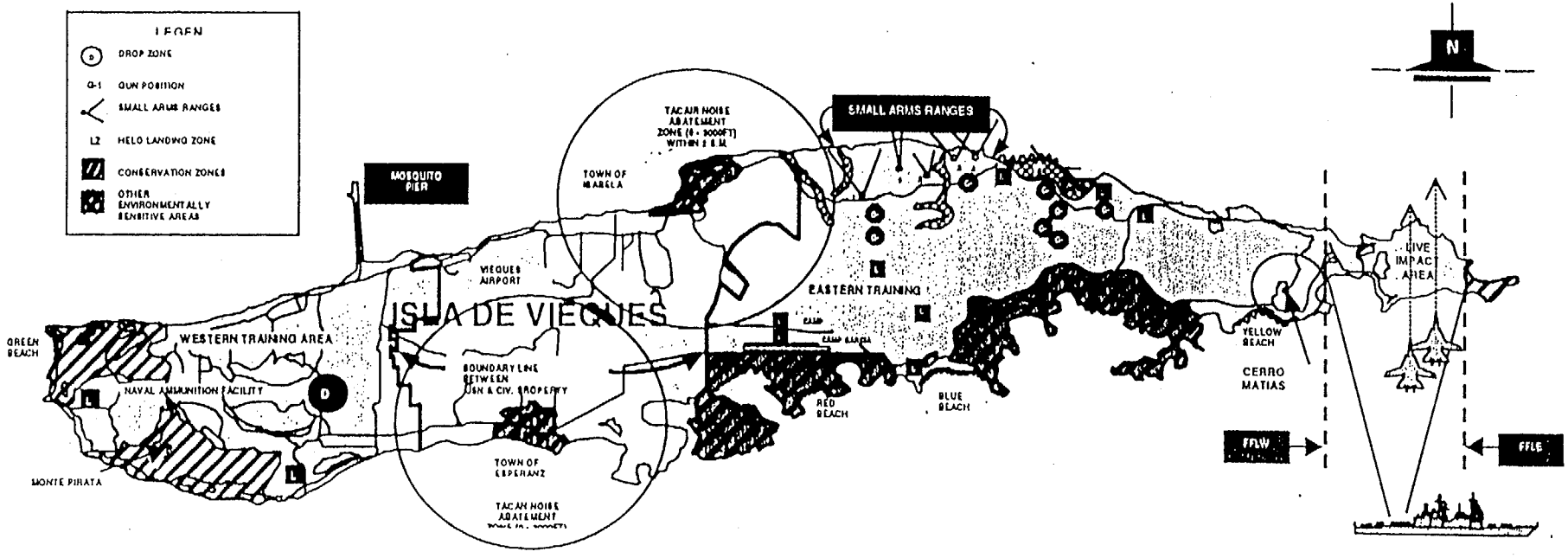


Figure 2. North Convoy Site.

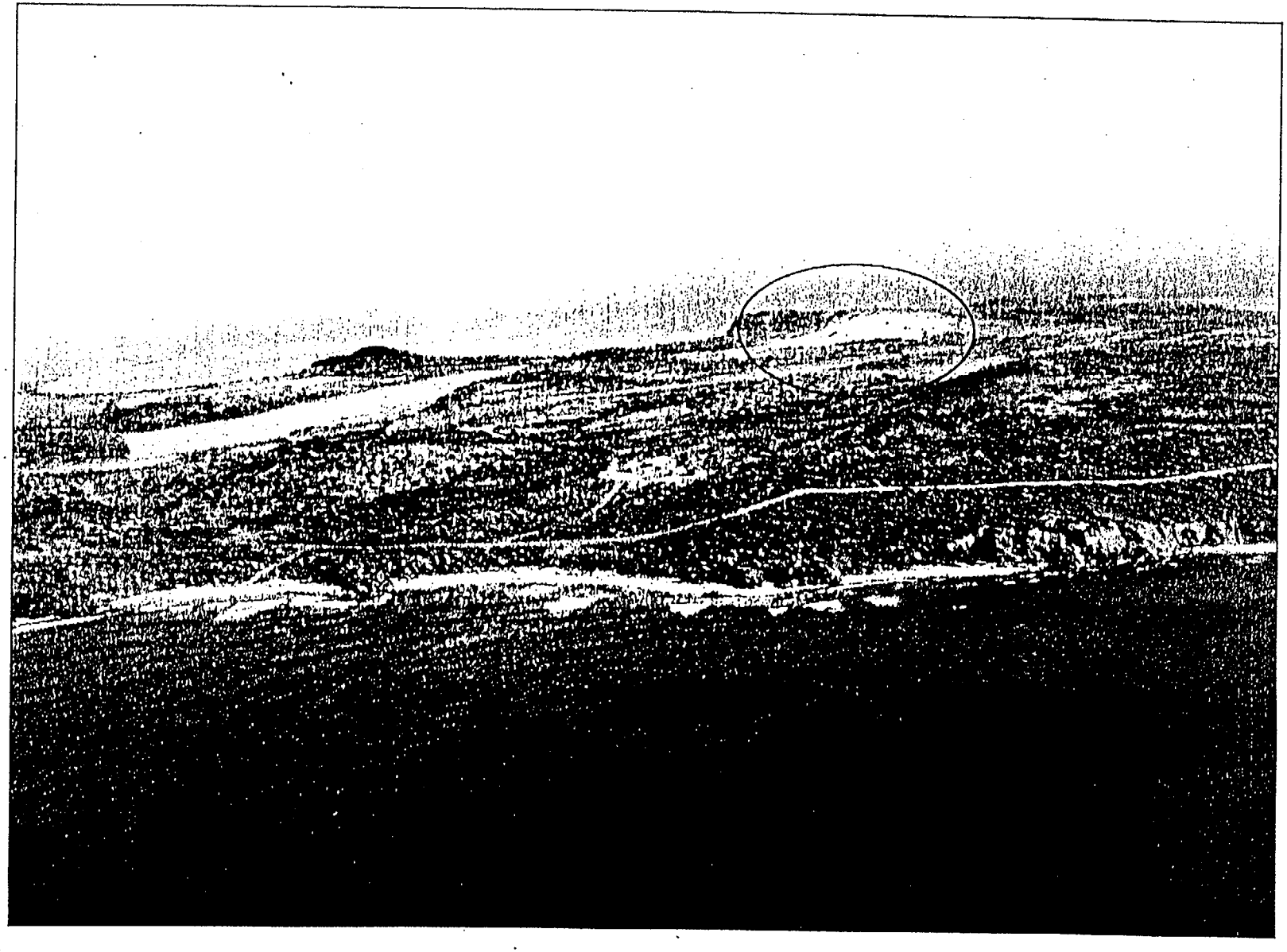


Figure 3. Affected Area of North Convoy Site and Harrier Aircraft Line-of-Fire.

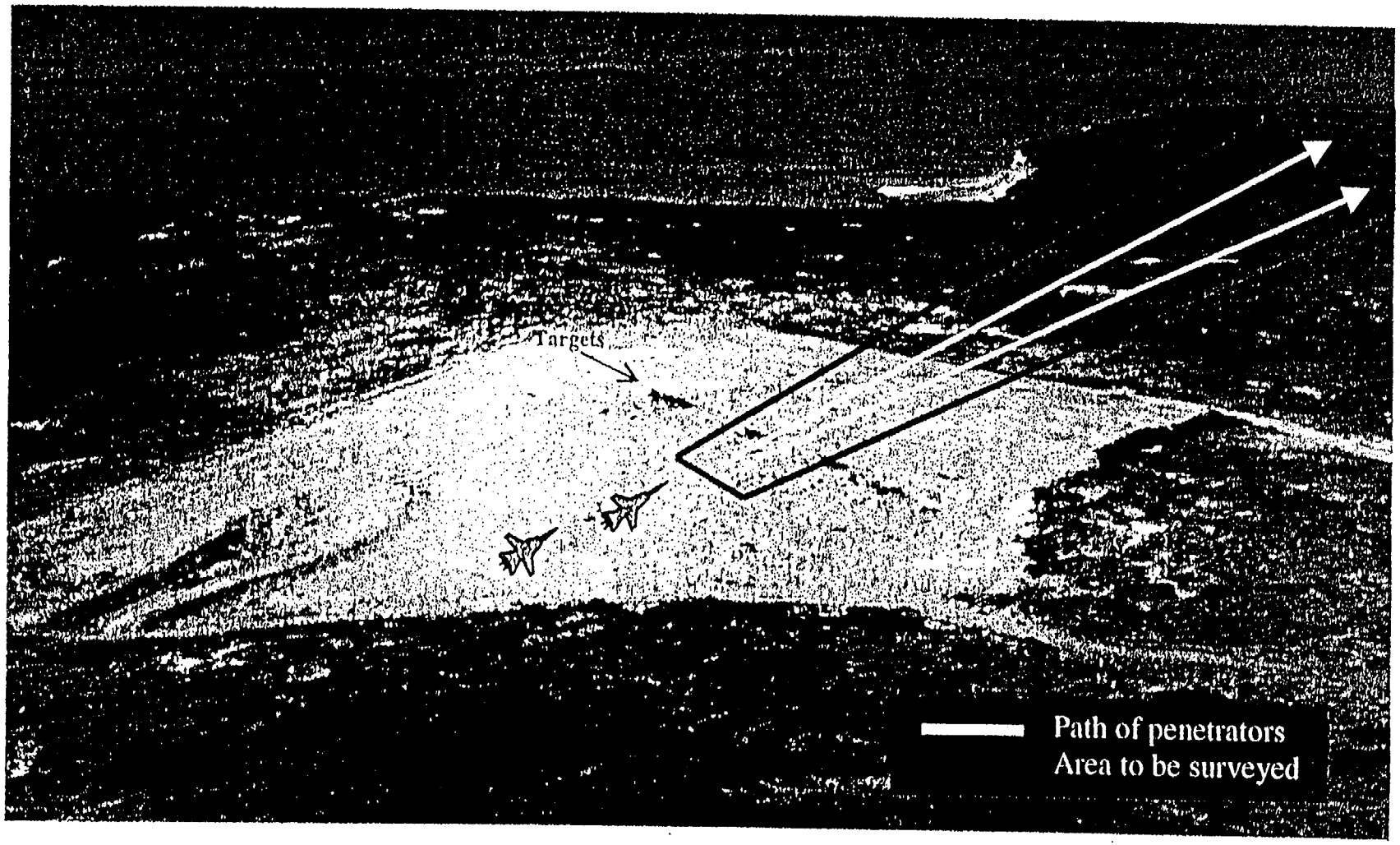
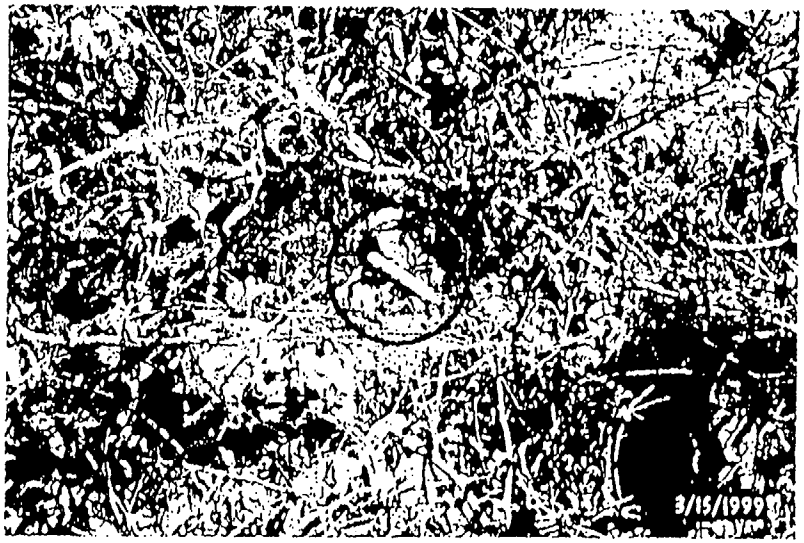


Figure 4. DU penetrators previously located on the North Convoy Site.

Penetrator located on the surface.



Penetrator located (buried) in soil.

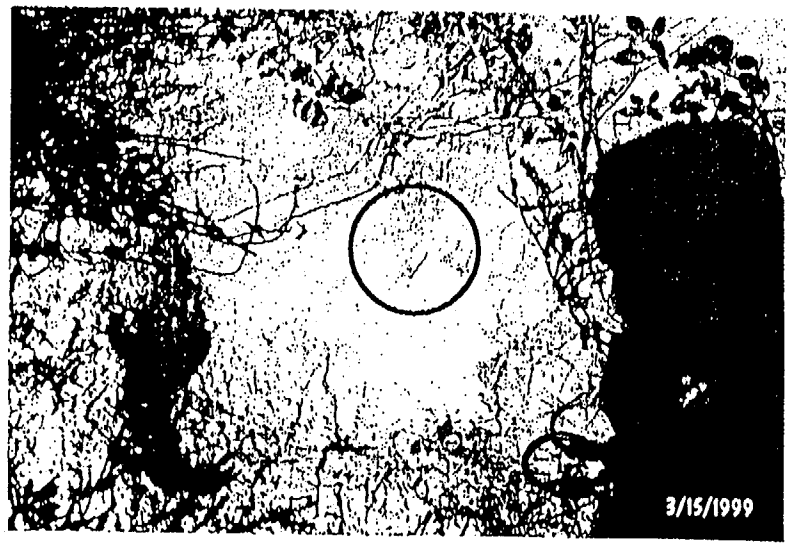


Figure 5. Area of North Convoy Site Previously Surveyed.

Figure 6. Radiological Scan Survey Equipment.

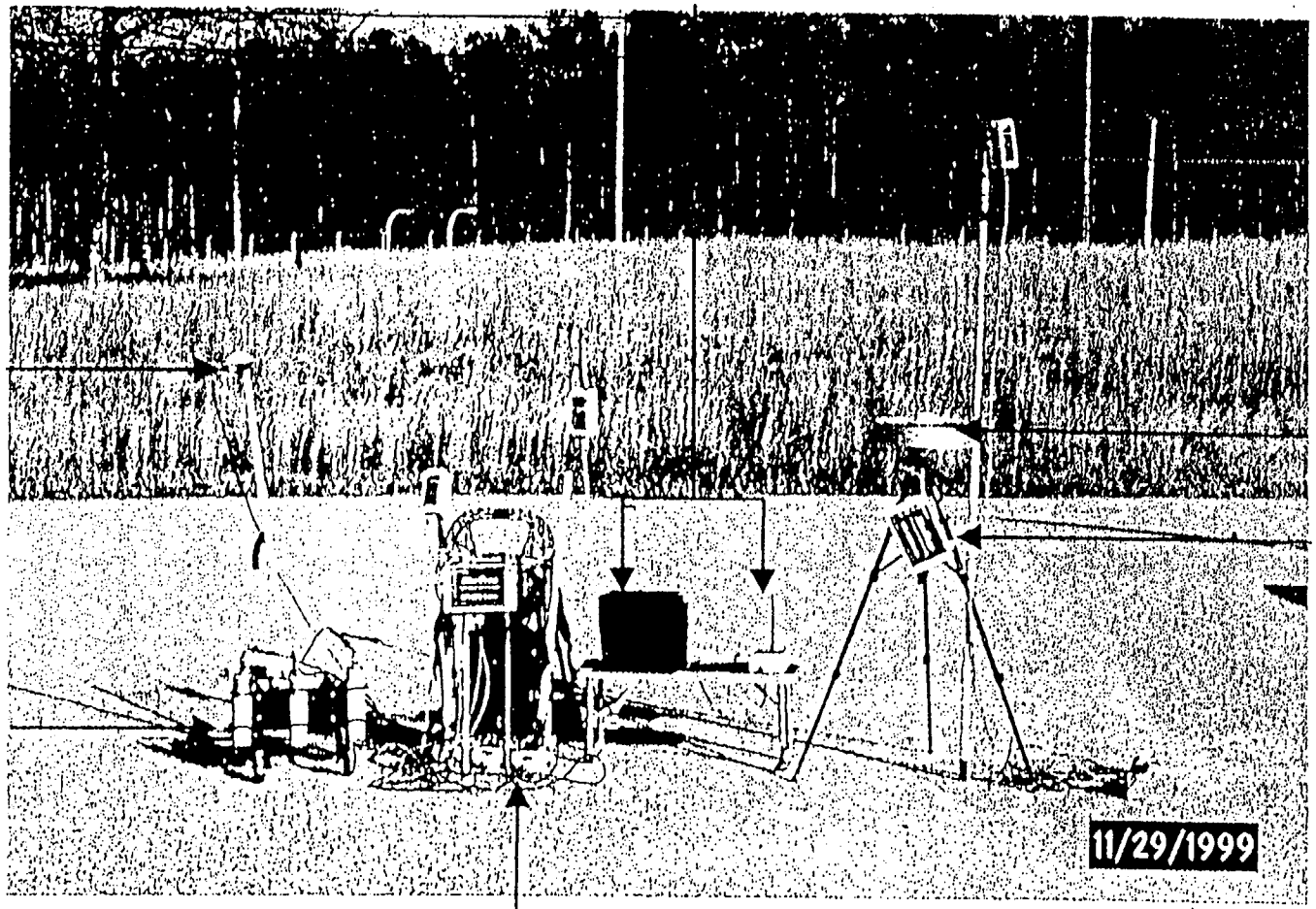
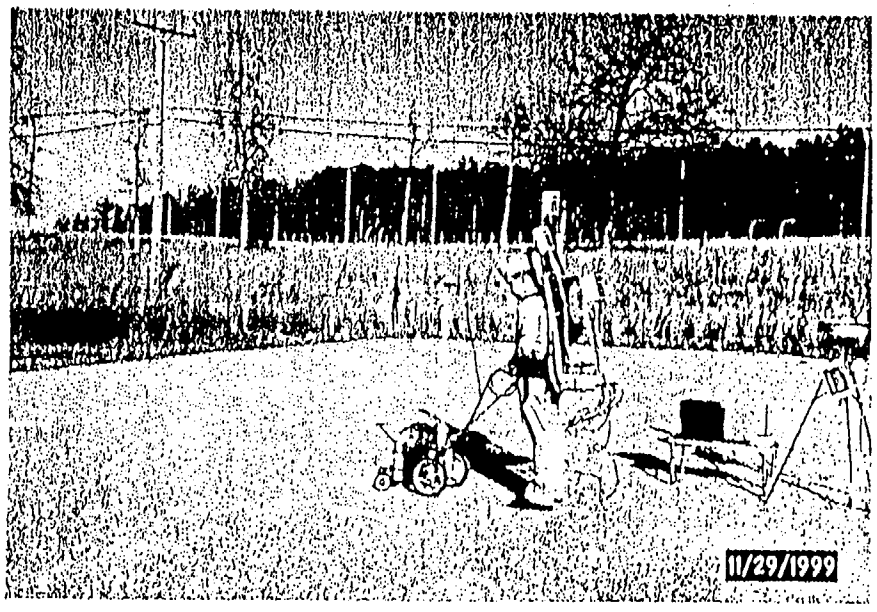
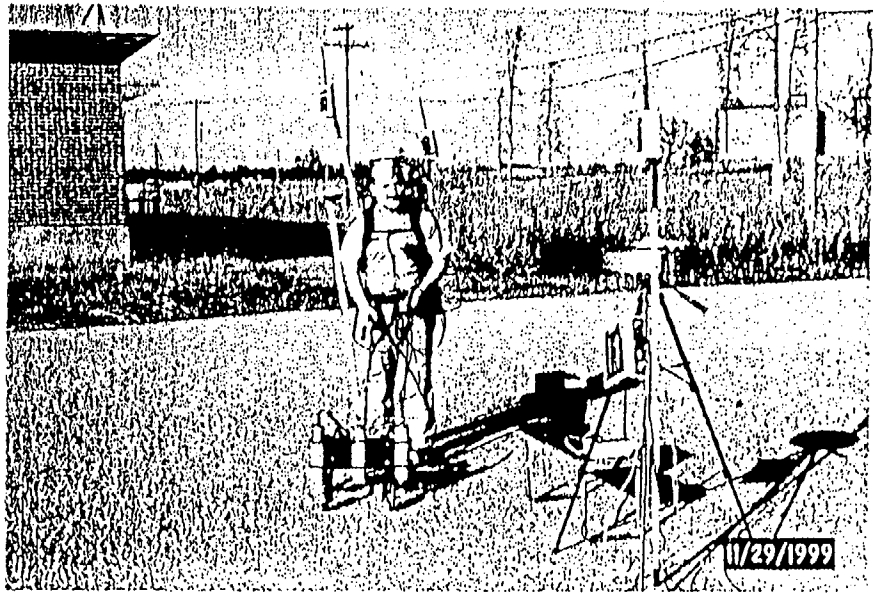


Figure 7. Radiological Scan Survey and Real Time Track Map of Area Surveyed.





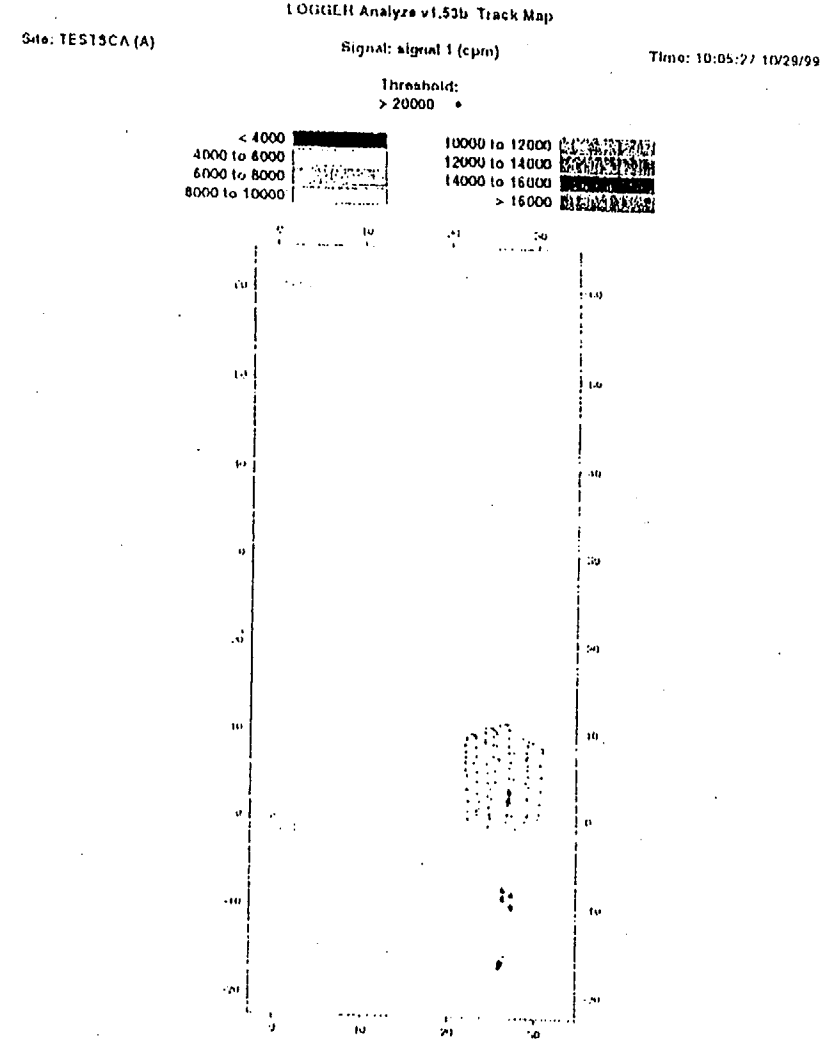
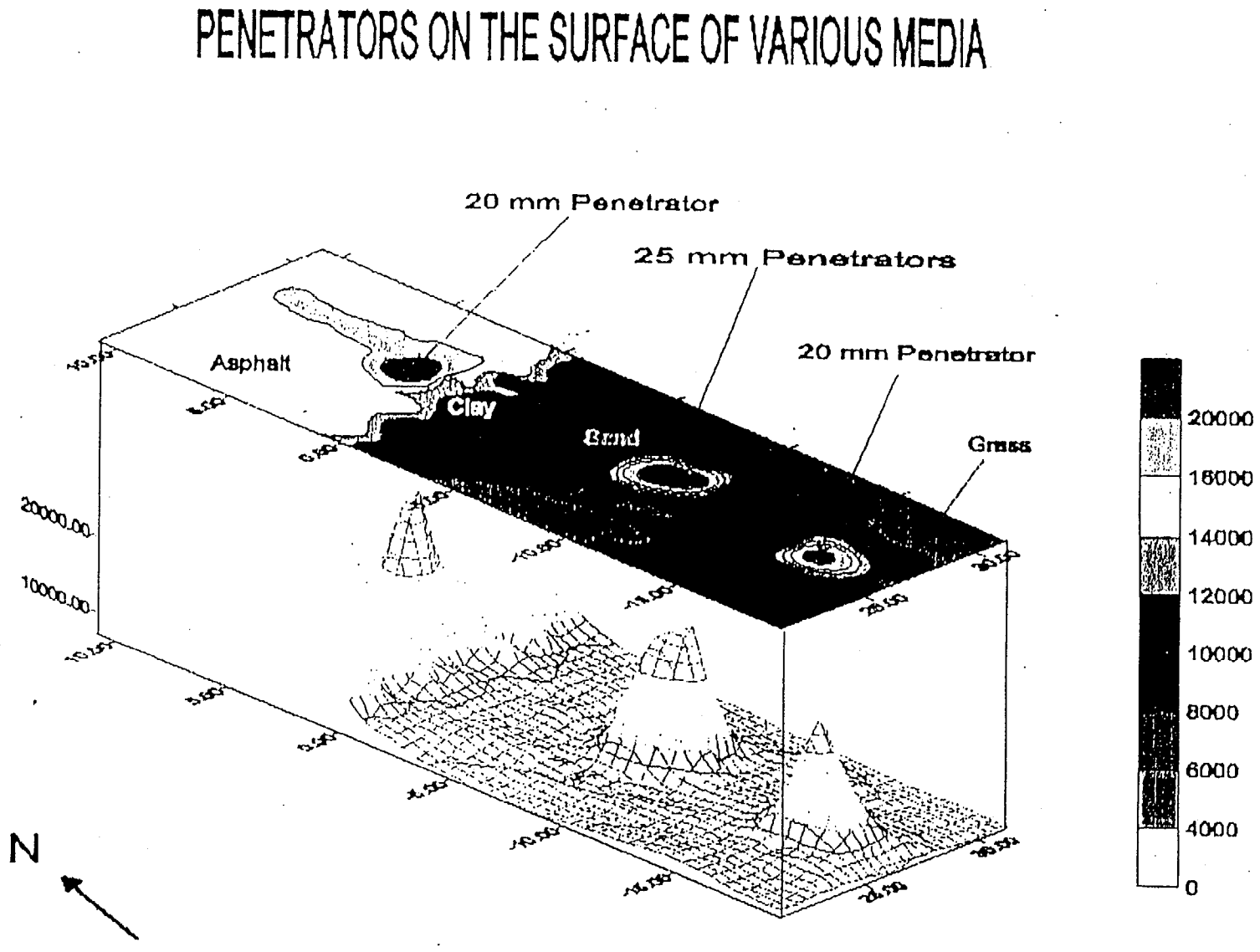



Figure 8. Stack Map Used to Analyze Scan Survey Data.