Final Status Survey of Haul Road

Submitted to:

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INTRODUCTION

Shieldalloy Metallurgical Corporation (SMC) operates a facility located in Newfield, New Jersey. This facility manufactures or has manufactured specialty steel and super alloy additives, primary aluminum master alloys, metal carbides, powdered metals, and optical surfacing products. Raw materials currently used at the facility include beneficiated ores which contain oxides of columbium (niobium), vanadium, aluminum metal, titanium metal, strontium metal, zirconium metal, and fluoride (titanium and boron) salts. During the manufacturing process, the facility generates a variety of by-products that have commercial application.

SMC is licensed by the U. S. Nuclear Regulatory Commission (USNRC) to ship, receive, possess, use, and store source material pursuant to License No. SMB-743. The primary forms of source material currently present at the site include ores used as feed to metallurgical operations, byproduct slag used as a slag fluidizer, and baghouse dust.

The Haul Road was, at one time, a county right-of-way that ran through SMC's Newfield plant. Over the years, the south portion of Haul Road was surfaced with crushed slag from SMC operations. Although the Haul Road was never used to perform principle activities authorized by License No. SMB-743, it was nonetheless included in site characterization efforts that took place in 1988 and in 1991.[1,2] These surveys showed that the contact exposure rates in and near the Haul Road were only slightly discernible from background, and that the slag used to form the road bed was not characteristic of licensed material (i.e., ferrocolumbium slag).[3]

Purpose

During a 1997 inspection by the USNRC, the issue of remediating the Haul Road was raised.[4] At that time, SMC agreed to address this issue as part of other planned remedial activities.

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[1] Oak Ridge Associated Universities, "Radiological Survey of the Shieldalloy Metallurgical Corporation, Newfield, New Jersey", Report No. ORAU 88/G-79, July, 1988.

[2] IT Corporation, "Assessment of Environmental Radiological Conditions at the Newfield Facility", Report No. IT/NS-92-106, April 2, 1992.

[3] Exposure rates in and near the Haul Road generally ranged from background to 26 microR per hour, with a maximum exposure rate of 90 microR per hour. The contact exposure rate from ferrocolumbium slag is in the vicinity of 1,000 to 2,000 microR per hour.

[4] U. S. Nuclear Regulatory Commission, Inspection Report No. 040-07102/97-001, September 24, 1997.

In 1998, the issue was raised again by the USNRC in relation to timeliness of decommissioning requirements.[5,6] In response to that inquiry, SMC escalated the remedial action schedule.

Between September 2 and 18, 1998, the residual slag from the Haul Road was scraped and transferred to the Storage Yard. During the week of September 14, 1998, a final status survey of the remediated area was performed in order to demonstrate that the Haul Road may be released for unrestricted use (i.e., without regard for radiological constituents).

Scope

The final status survey of the remediated Haul Road was performed following the guidance provided in NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM). The effort included a walkover survey of the entire Haul Road, including all remediated areas and the land area immediately adjacent to the remediated areas. It also included the collection and analysis of soil samples from both the remediated area and from a number of background locations.

This document serves as the final status survey report for the Haul Road. It contains a summary of the project and its methods, the data acquired, and a comparison of survey findings to the site-specific release criteria.

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[5] U. S. Nuclear Regulatory Commission, Inspection Report No. 040-07102/98-001, August 27, 1998.

[6] U. S. Nuclear Regulatory Commission Administrative Letter 96-05, Revision 1, July 14, 1998.

FACILITY INFORMATION

Contaminants of Concern

SMC is licensed to possess uranium and thorium in any form suitable for transport under Department of Transportation regulations. Previous studies of the radionuclide content of the materials typically found at the site are indicative of a natural distribution of the radioactive progeny of these series radionuclides. Therefore, the contaminants of concern for this final status survey include ^{232}Th plus progeny in equilibrium, and ^{238}U, plus progeny in equilibrium.

Release Criteria

SMC Radiation Safety Procedure No. RSP-009, "Contamination Control" contains the release criteria for the Newfield facility. These criteria are also shown in Table 1. For the walk-over survey, a screening level of 15 microR per hour above background, at a distance of three (3) centimeters from the soil surface was used.[7] Any location that exhibited an exposure rate in excess of this value was subject to additional remedial action prior to being re-surveyed.

[7] Berger, C.D., Integrated Environmental Management, Inc., "Screening Criteria for Soils", written communication to David R. Smith, Shieldalloy Metallurgical Corporation, September 1, 1998.

SURVEY APPROACH AND PROCEDURES

Project Organization

All field work was managed by Mr. Alan Duff, R.R.P.T., an employee of **IEM**. During performance of the final status survey, Mr. Duff was responsible for designating the temporary restricted area in which work was performed, directing the work of other support staff, performing the survey activities, and assisting in the compilation of this report.

Technical oversight for the project was the responsibility of Ms. Carol Berger, C.H.P., an employee of **IEM**. Ms. Berger reviewed and approved all project plans, assisted in the review of the quality of data collected and the preparation of this report, and provided an interface between SMC and project personnel. Mr. Alex Boerner, C.H.P., also of **IEM**, provided additional data quality review, technical support and peer review of this report.

The field team was comprised of two health physics technicians who were qualified as "Radiation Surveyors" pursuant to SMC Radiation Safety Procedure No. RSP-006, "Training and Qualification of Radiation Personnel". Mr. Alan Duff served a dual role as both health physics technician and as Field Manager. Mr. Ronn Merkel formed the remainder of the field team.

Appendix A contains a summary of the qualifications of all **IEM** project personnel. Representatives of SMC observed some of the survey activities while they were on-going. In addition, SMC was given an opportunity to review and comment on a draft before this final status survey report was issued.

Survey Protocol

Instrumentation used to acquire measurement data was appropriate for the type of radiation expected, of sufficient sensitivity and accuracy to detect the radioactive materials found at the SMC facility, and of sufficient quantity to support the activities. Each instrument was labeled with a unique identifier (e.g., serial number of detector and rate meter) to enable traceability between instrument and survey records. Table 2 contains a listing of each instrument type used for the surveys. The instrument calibration records are located in Appendix B. Copies of the daily instrument check forms are located in Appendix C.

The survey was conducted by walking over 100% of the surface to be monitored and moving the detector in a serpentine pattern with the detector in close proximity to the ground. When the health physics technician detected elevated activity in a particular location, he would pause and obtain a stationary count rate in that area. Any area exhibiting residual radioactivity above the applicable criterion during a stationary count was identified with paint, remediated, and the survey repeated.

Reference Grid System for Survey Measurements

A grid system was established to facilitate the final status survey of the Haul Road. Gridding consisted of a system of intersecting lines, referenced to a fixed site location or benchmark.[8] The grids were approximately the width of Haul Road (~15') and were numbered one (1) through 50, starting at the south end of the road. Appendix D contains a diagram showing the grid system.

Sampling Objectives

A total of 25 soil samples were obtained from the remediated Haul Road and from a variety of background locations. The number of collected samples was determined using the statistical approach outlined in MARSSIM.[9,10] The samples were forwarded to an offsite analytical laboratory where they were analyzed by the methodology of gamma spectroscopy.

Radiation Safety Procedures

Health and safety provisions were established to permit the final status survey to be conducted without adverse impacts on worker health and safety. In general, these followed the recommendations in **IEM**'s Radiation Safety Procedure No. RSP-031, "Health and Safety Planning", as well as all applicable SMC Radiation Safety Procedures. The topics included work area entry, control of work, training, emergency procedures, ALARA, contamination controls, protective clothing, personnel monitoring, non-radiological hazards, and lighting considerations.

Data Conversion

Ambient gamma count rate data were converted to units of net exposure rate by the following methodology:

$$R_{net} = R_{gross} - BKG_{ave} \times CF$$

where R_{net} = the net measured exposure rate (μR/hr), R_{gross} = the gross measured exposure rate (μR/hr or cpm), and CF = a conversion factor to convert count rate instrument readings into units of "μR/hr". Appendix E contains the technical bases for comparing instrument response (scan and stationary mode) to the release criteria.

The radionuclide concentration in soils collected from the Haul Road were reported, by the laboratory, in units of picocuries per gram (pCi/g). Therefore, no further conversion of these data was required.

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[8] Typically, the grid lines were arranged in a perpendicular pattern, dividing the location into squares or blocks of equal area.

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

[10] Pursuant to Table 5.3 of MARSSIM, a total of 13 samples from the affected area and 13 samples from background locations are required in order to compare survey results to release criteria. However, three (3) background soil samples that were collected on August 3, 1998 for another purpose and subsequently analyzed by gamma spectroscopy (for another purpose) satisfied three (3) of the 13 background sample requirements.

Detection Limits

The detection limit for surface counts acquired over a pre-set time period was determined by the following methodology:

$$MDA = \frac{2.71 + 4.65\sqrt{BKG_{ave} \times t}}{t \times E}$$

where MDA = the activity level (microR/hr), BKG_{ave} = the background count rate for this measurement type (cpm), E = a factor (see Appendix E) used to convert instrument response (cpm) into exposure rate (microR/hr), and t = the measurement duration (min).

The MDA for an instrument operating in the ratemeter mode was determined by:

$$MDA = \frac{4.65\sqrt{\frac{BKG_{ave}}{2t_c}}}{E}$$

where t_c = the meter time constant (min).

Measurement Uncertainty

Certain measurement values include an assessment of the uncertainty associated with that value. The following is the methodology that was used to determine the "error" associated with those measurements:

$$s_r = 1.96\sqrt{\frac{c}{t^2} + \frac{BKG_{ave} \times t_{BKG}}{(t_{BKG})^2}}$$

where t_{BKG} = the time period over which the background data were acquired.

RESULTS

Background Determination

Background measurements were made in non-impacted areas of the SMC facility in accordance with IEM Radiation Safety Procedure No. RSP-018, "Surveillance" These ranged from 8,000 to 16,000 counts per minute, with the higher rates noted proximal to the Storage Yard.

A total of 13 soil samples were collected from the western-most portion of the Newfield site, which is a non-impacted area. The natural uranium and natural thorium concentrations in these samples were on the order of one (1) picocurie per gram (pCi/g) each.

Exposure Rates

As shown in Appendix D, gamma count rates ranged from background to approximately 17,000 counts per minute including background. All of these locations met the exposure rate release criteria shown in Table 1.

Analytical Results

Approximately one (1) kilogram soil samples were collected from 15 locations within the remediated Haul Road as shown in Appendix D. Each soil sample was analyzed for the presence of gamma-emitting radionuclides.

Because the licensed materials at SMC exhibit equilibrium between the parent and progeny of both the uranium and thorium decay series, the reported ^{228}Ac concentration is reasonably representative of the elemental concentrations in the ^{232}Th series. Likewise, the ^{214}Bi concentration is reasonably representative of the elemental concentrations in the ^{238}U series. In general, thorium concentrations ranged from 0.5 to 1.8 pCi/g, and uranium concentrations ranged from 0.4 to 3.6 pCi/g.

The Wilcoxon Rank Sum procedure specified in Section 8.4.2 of MARSSIM was used to compare the Haul Road analytical data to the background analytical data. The critical value selected for the comparison of the summed ranks of the two data sets was taken from Table I.4 of MARSSIM, using a Type I decision error of $\alpha = 0.05$. The null hypothesis for the test was that the isotopic concentration in the Haul Road samples exceeds the isotopic concentration in the background samples.

Tables showing the statistical tests for each radionuclide are contained in Appendix F. These show that for all radionuclides, the sum of the reference area ranks exceeds the critical value. Thus the null hypothesis is rejected (i.e., the residual radioactivity in this area meets the site-specific release criteria).

SUMMARY AND CONCLUSIONS

On September 15 through 18, 1998, a final status survey of the Haul Road, a former county access road that runs to the south of SMC's Newfield, New Jersey facility was performed. The methodology used to complete the survey was consistent with the guidance contained in MARSSIM.

The data acquired demonstrate that residual radioactivity in the Haul Road meets the site-specific release criteria shown in Table 1 of this report. Consequently, once a validation survey has been performed, if so required by the regulatory agency, the remediated areas of the Haul Road may be back-filled and put to any use without regard for residual radiological constituents.

TABLES

Table 1 - Site-specific Release Criteria

TYPE	NUCLIDE[1]	REMOVABLE[2,4]	TOTAL[2,3] (FIXED PLUS REMOVABLE)	CONCENTRATION[6, 7]
Surface	U-nat, U-235, U-238 and associated decay products	1,000 dpm α/100 cm^2 above background	5,000 dpm α/100 cm^2 above background	--
Surface	Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200 dpm/100 cm^2 above background	1,000 dpm α/100 cm^2 above background	--
Surface	Mixture of U-nat and Th-nat	--	600 dpm α/100 cm^2 by *direct frisk* above background[5]	--
Soil Volume	U-238 and U-234 with progeny in equilibrium	--	--	2.5 pCi/g each above background, averaged over the volume of interest
Soil Volume	Th-232 and Th-228 with progeny in equilibrium	--	--	2.5 pCi/g each above background averaged over the volume of interest
Soil Volume	Mixture of U-nat and Th-nat	--	--	15 microR per hour above background[8]

[1] Where surface contamination by both α and β-gamma-emitting radionuclides exists, the limits established for α and β-gamma-emitting radionuclides should apply independently.

[2] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[3] The levels may be averaged over 1 m^2, provided the maximum surface activity in any area of 100 cm^2 is less than three times the guide values. For purposes of averaging, any square meter of surface shall be considered to be above the activity guide G if: (1) from measurements of a representative number (n) of sections it is determined that $1/n \sum_n S_i > G$, where S_i is the dis/min-100 cm^2 determined from measurement of section I; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds 3G.

[4] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. (Note - The use of dry material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. Except for transuranics and Ra-226, Ra-228, Ac-227, Th-228, Th-230, and Pa-231 α emitters, it is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

[5] Assumes removable activity is the limiting value.

[6] Taken from U. S. Nuclear Regulatory Commission, Option 1 of the Branch Technical Position "Disposal or Onsite Storage of Thorium or Uranium Wastes From Past Operations", 46 FR 52061, October 23, 1981.

[7] Concentrations may be averaged over the soil volume of interest as described in U. S. Nuclear Regulatory Commission, Final Staff Technical Position, "Disposition of Cs-137 Contaminated Emission Control Dust and Other Incident-related Material", 62 FR 13176, March 19, 1997.

[8] Assumes 2.5 pCi/g each of Th-232, Th-228, U-238, and U-234 (plus progeny in equilibrium) evenly distributed throughout the soil volume to a depth of 15 cm, with measurements made at a height of less than three (3) cm above the soil surface. Taken from Integrated Environmental Management, Inc., written communication to D. R. Smith, "Screening Criteria for Soils", September 1, 1998.

Table 2 - Survey Instrumentation Data

Instrument Model	Detector	Use	Nominal Background	Efficiency	Detection Sensitivity
Ludlum Model 2241 scaler/ratemeter	Ludlum Model 44-10 NaI	Walkover gamma survey	5000-8000 cpm	N/A	900 cpm per μR/hr
Ludlum Model 2224 scaler/ratemeter	Ludlum Model 43-89 dual alpha/beta contamination	Contamination surveys of sampling equipment and sample containers	Alpha- 3 cpm or less Beta- 300 cpm or less (10 μR/hr field)	17%- 4π (Th-230 alphas)	N/A

APPENDICES

Appendix A - Personnel Qualifications

R. Alan Duff - Project Manager and Health Physics Technician

Professional Qualifications

Mr. Duff has over nineteen years of experience in nuclear and hazardous materials project management, design support, surveillance, operational health physics, training, and decommissioning activities. He has prepared numerous plans, procedures, and license documents for U. S. Department of Energy facilities, U. S. Department of Defense facilities, U. S. Nuclear Regulatory Commission licensees, and commercial client facilities that are regulated by agreement states. Mr. Duff is well versed in the area of civilian and government radioactive and mixed waste transport and disposal requirements. He is registered by the National Registry of Radiation Protection Technologists (NRRPT).

Education

Advanced Radioactive Material Transportation and Disposal Class, 1989 and 1993
IT Corporation Project Management Course (40 hours), 1992.
40-Hour OSHA HAZWOPER (29 CFR 1910.120) Training, 1987.
Eight-hour Supervisor Training, 1990
Eight-hour OSHA Annual Refresher (29 CFR 1910.120), 1997, 1998.
Canberra Multichannel Analyzer Operations Class, 1988.
Operational Water Chemistry and Radiological Controls, U.S. Navy, 1982
Engineering Laboratory Technician School, U.S. Navy, 1980.
Nuclear Power Training Unit (prototype), U.S. Navy, 1980.
Naval Nuclear Power School, U.S. Navy, 1978.

Registrations/Certifications

Registered Radiation Protection Technologist (RRPT), National Registry of Radiation Protection Technologists

Experience and Background

1995 - Present *Project Manager, Integrated Environmental Management, Inc., Knoxville, Tennessee.* Provides high-quality project management and remediation services to commercial and government clients. As a member of the client's response team, works with clients to: Develop scopes-of-work and bid packages for specialty subcontractors handling highly focused assignments; identify those subcontractors who will provide the greatest value to the client; manage teams of specialty subcontractors to ensure that the client's goals and expectations (technical, regulatory, and financial) are met from the beginning until project completion; provide insights into future regulatory issues and their impact as input to the client's long-range business planning and cost forecasting process; provide site remediation/decommissioning services for radioactive and hazardous materials; and develop project specific plans and procedures to conduct on site activities. Mr. Duff also serves as the Radiation Safety Officer (RSO) for IEM operations.

1994 - 1995 *Senior Environmental Specialist, AWK Consulting Engineers, Inc., Pittsburgh, Pennsylvania* While assigned to the Oak Ridge, Tennessee office, was responsible for performing technical and administrative duties required to satisfy customer needs on site characterization and pre-remedial design support projects and for all aspects of D&D projects. Responsible for preparing project plans, project work plans, task specific Health & Safety Plans, and budgets/schedules for these projects. Also responsible for identifying and implementing decommissioning and decontamination methods for these projects.

1987 - 1994 *Project Manager, Health Physics Supervisor, Nuclear/Mixed Waste Engineering Services, IT Corporation, Knoxville, Tennessee.* Provided project management and health physics support services for nuclear and mixed waste projects throughout the United States.

1978 - 1987 *Engineering Laboratory Technician (ELT), Leading Petty Officer, Radiological Controls Shift Supervisor, United States Navy.* Supervised a division of 40 personnel, provided support for nuclear powered submarines, and performed over 250 error-free shipments of radioactive materials. Served as Leading ELT and Engine Room Supervisor on the USS Grayling, SSN 646.

Professional Society Memberships

Health Physics Society (Plenary Member)
American Nuclear Society
Conference of Radiation Control Program Directors (Advisor to the Radioactive Waste Management Committee E-5 and to the D&D Committee E-24)
International Society of Decontamination and Decommissioning Professionals

Awards

Navy Achievement Medal for conducting the first Trident Class submarine ion exchange resin discharge and solidification.
IT Corporation *Project Management Associate*

Example Project Descriptions

- Project Manager for escalated decommissioning a State-licensed site that manufactured, tested, and distributed gauging devices in anticipation of the sale of the company and the possibility of its moving its operations to another location. Responsible for preparation of work plans, negotiations with regulatory agencies, decontamination of indoor and outdoor areas, performance and documentation of a final status survey, shipment of waste, and project-specific health and safety.

- Project Manager and health physicist for the remediation of a building foundation drainage system and the processing of over 100,000 gallons of

water contaminated with cobalt-60 up to levels of one (1) μCi per liter for a commercial client. Responsible for coordination of a water processing subcontractor, an excavation subcontractor, and off-site analytical laboratory activities. Also interfaced with on-site U. S. Nuclear Regulatory Commission, U. S. Environmental Protection Agency, and a variety of state and local agencies.

- Project Manager for the decommissioning and decontamination of three facilities at Sandia National Laboratory contaminated with radioactive and mixed waste. Responsible for the coordination of resources for the development of project plans, development of Project Work Plan, and maintaining project budget and schedule commitments.

- Project Manager for the excavation and disposal of radium waste cells for the Corps of Engineers at Bergstrom Air Force Base in Austin, TX. Developed all project plans, supervised field efforts, and coordinated waste disposal activities.

- Project Manager for the decontamination and final release survey of a 70,000 ft^2 facility that manufactured cesium-137 level gauges. Decontamination efforts involved overhead areas, work area concrete floors, and removal of soil under the floor slab. Facility was released from their license following a verification survey by the state radiological licensing agency. Developed state approved decommissioning plan and final status survey report.

- Project Manager for the packaging and disposal of 55,000 Curies of cobalt-60 teletherapy sources. Sources were loaded into cask liners in the facility hot cell and loaded into Type B casks for shipment for disposal. Also supported the packaging and disposal of several low level waste drums and HEPA filters that required the use of shielded Type A and B shipping containers.

- Project Manager for the decommissioning and decontamination of IT's Oak Ridge Mixed Waste Analytical Laboratory. Developed the decommissioning and decontamination plan that was approved by the State of Tennessee. Also supervised the field crew during final surveys of facility.

- Project Manager for the decommissioning and decontamination of a magnesium-thorium waterfall grinding booth at Tinker Air Force Base in Oklahoma. Responsible for the development of project plans, schedule and budget management, and disposal of radioactive and mixed wastes.

- Project Manager for the decommissioning of a commercial facility which had previously processed ores containing uranium and thorium. Generated the

decommissioning plan submitted to and approved by the U. S. Nuclear Regulatory Commission, and was responsible for schedule, budget, and on site activities.

- Project Manager for the removal of a 22 MeV particle accelerator from a major university medical center. Developed State-approved decommissioning and decontamination plans, arranged for waste disposal and transfer of the accelerator to a university in Beijing, China, and was responsible for budget, schedule and all on site activities.

- Project Manager for the decommissioning and decontamination of two radioactive source manufacturing laboratories at Chevron Research and Technology. The laboratories housed a neutron generator and were contaminated with tritium, carbon-14, cesium-134, and cobalt-60. Negotiated plan approvals with the State agency, and was responsible for budget, schedule, and all on site activities.

- Project Manager for the routine quarterly surveillance and special radiological projects at a metallurgical facility licensed by the NRC. Conducted radiation, contamination, and airborne radioactivity surveys as well as personnel bioassay and dosimetry program and environmental monitoring program each quarter. Provided health physics coverage for non-routine activities such as baghouse and stack testing, heats of specialty materials, and recovery of radioactively contaminated equipment improperly released from site. Responsible for the generation of quarterly surveillance reports.

- Project Manager for the development of a conceptual decommissioning plan for a maintenance facility located in South Carolina. The plan was generated to provide support for the facility's decommissioning funding plan.

- Health and Safety Manager/Project Manager at the U. S. Department of Energy's Fernald site thorium silo and bins decommissioning and decontamination project. Developed the project-specific health and safety plan, and interfaced with the client on health physics and health/safety issues. This project received safety and quality awards from the client.

- Health Physics Supervisor responsible for the sampling of underground storage tanks with radioactive and mixed wastes at Brookhaven National Laboratory.

- Health Physics Supervisor for a transuranic (TRU) waste repackaging project. Supervised the characterization, repackaging and shipment of 130 containers of high-activity americium-241 and plutonium-238 hot cell waste. The waste was packaged to meet the WIPP waste acceptance criteria and was transported

(highway route controlled quantity) to the Idaho National Engineering Laboratory (INEL) for storage.

- Health and Safety Manager for the U. S. Department of Energy's Fernald Plant K-65 Silo sampling project. Developed the health/safety and sampling plans. The silos contained up to 0.5 μCi of Radium-226 per gram and were the largest single source of radon gas in the U.S.

- D&D Technical Manager for the decommissioning of the U. S. Department of Energy's LEHR facility at the University of California at Davis. Developed project decommissioning and decontamination plans and field procedures.

- Health Physics Supervisor for the excavation of waste materials which included mixtures of uranium and explosives.

- Technical writer for the Fernald Remedial Investigation/Feasibility Study (RI/FS). Provided technical guidance to engineering staff, generated reports on radioactive and mixed waste packaging, transport, and disposal.

- Technical writer for the development of a logic flow diagram for identifying radioactive and mixed wastes at the U. S. Department of Energy's Portsmouth (Ohio) Gaseous Diffusion Plant.

- Proposal Coordinator for over 40 business proposals for nuclear decommissioning and decontamination projects including job walk downs, cost estimation, scheduling, and technical content of proposals.

Ronn Merkel - Health Physics Technician

Professional Qualifications

Mr. Merkel has over nine (9) years of experience in the radiation protection field, with emphasis on decontamination, site surveillance and applied health physics.

Education

Shoreham Wading River High School (diploma)
Suffolk Community College (Summer Session)
Christ for the Nations Bible College (AS degree)
Computer Aided Design (Certificate)
Drafting (3 years)
OSHA 40-hour Waste Worker Training (Certification 9140B0155)
U. S. Department of Energy Core Course (Health Physics)
Radiation Worker Training - MK Ferguson (June, 1994)
General Employee Training - MD Ferguson (June, 1994)

Experience and Background

December 1995-Present - Health Physics Technician, Integrated Environmental Management, Inc. (Knoxville, Tennessee) - Duties include surveillance activities, instrumentation usage/control, decontamination, site characterization, documentation, and other general health physics duties.

June, 1994-November, 1995 - Sr. Health Physics Technician, STEP, Inc. (Oak Ridge, Tennessee) - Duties included all aspects of health physics, radiation and contamination surveys; performance of free-release surveys; packaging of radioactive waste; instrument calibration; and site health physics.

February, 1994-April, 1994 - Sr. Health Physics Technician, UCAR Carbon (Cleveland, Ohio) - Duties included free-release survey o facility contaminated with ^{137}Cs, decontamination of areas that were observed to be greater than background readings; setup of all applicable instrumentation; shipment of radioactive waste.

August, 1993-December, 1993 - Health Physics Technician, Comanche Peak Power Plant (Granbury, Texas) - Duties included radiological surveys of surfaces, equipment and personnel; control point operations; counting room operations; and other health physics duties.

January, 1993-September, 1993 - Health Physics/Chemistry Technician, Terra Analytical Laboratory (Granbury, Texas), - duties included setup of a fully-equipped analytical laboratory; assisted in preparation of procedures to obtain radioactive materials license;

purchase, setup and calibration of various analytical equipment; and drafting operating procedures for lab equipment.

May, 1992-December, 1992 - Sr. Health Physics Technician, Radion Sterilizers, Decatur, Georgia - Duties included supervision of decontamination technicians, performance and documentation of radiological surveys, initiation of Radiation Work Permits, routine air sampling, packaging and shipment of radioactive waste, setup and coverage of systems, daily source checks of survey instruments, analysis of soil samples, preparation (drafting) of free-release survey maps, and other general health physics duties.

February, 1992-May, 1992 - Health Physics Technician, Bartlett (Assigned to Perry Nuclear Power Plant, Cleveland, Ohio) - Duties included radiological surveys of rooms, equipment and personnel; control point operations at entrance and exit of auxiliary building, and other general health physics duties.

August, 1991-December, 1991 - Jr. Health Physics/Senior Decon, Vogtle Unit 1, Waynesboro, Georgia - Duties included surveying and handling of radioactive waste and laundry, decontamination and release of tools and equipment, pre-release surveys and routine air sampling. Qualified in the use of various health physics instrumentation.

April, 1991- May, 1991 - Temporary Chemistry/QC Technician, Wheatland Farms, Inc., Dallas, Texas - Duties included sampling and chemistry analysis of all processed products. Analysis included %salt, fat content, pH, viscosity, conductivity, weights, and others. Also responsible for ensuring that work was conducted safely and with quality.

January, 1989-March, 1990 - Chemistry/Counting Room Technician, Alpha Nuclear Laboratories, Inc., Dallas, Texas - Duties included preparation and analysis of samples for Pb-210, total radium content, gross alpha and beta on solids and liquids, Po-210, and isotopic radium. All were performed in accordance with EPA protocols and ASTM-recommended methods.

July, 1988-December, 1988 - Jr. Health Physics/Senior Decon, Vogtle Unit 1, Waynesboro, Georgia - Duties included surveying and handling of radioactive waste and laundry, decontamination and release of tools and equipment, performance of pre-release surveys and routine air sampling; qualified in the use of various health physics instruments.

Carol D. Berger - Program Manager

Professional Qualifications

Ms. Berger has over twenty years experience in nuclear and radiological activities with emphasis in strategic planning, radiation dosimetry, instrumentation, and applied health physics. As a co-founder of **IEM**, Inc., Ms. Berger is actively involved in performance of radiological dose assessments, regulatory interactions, site decommissioning, program evaluations, program development, pathway analyses, risk assessments, dosimetry evaluations, assessment and control of sources of non-ionizing radiations, waste management programs, environmental monitoring programs, and detection and quantification of low-levels of radioactivity.

Education

M.S., Health Physics, San Diego State University, San Diego, California; 1979
M.S., Radiation Physics, San Diego State University, San Diego, California; 1977
B.S., Physics/Chemistry, San Diego State University, San Diego, California; 1972

Certifications

Certified Health Physicist (Comprehensive): American Board of Health Physics, 1983
Re-certified: 1987, 1991, 1995

Experience and Background

1994 - Present — *Founder, Integrated Environmental Management, Inc., Rockville, Maryland.*
Provides high-quality strategic environmental management services to commercial and government clients. As a member of the client's response team, works with clients to promote an understanding of what is required to achieve and/or maintain compliance in the eyes of all pertinent regulatory agencies, individually or jointly; develop an overall strategy for achieving compliance and reduce liabilities in a technically-sound, legally-defensible, and fiscally-conservative business manner; recommend specific solutions that are compatible with the client's operating philosophy; and provide insights into future regulatory issues and their impact as input to the client's long-range business planning and cost forecasting process.

1989 - 1994 — *Senior Technical Consultant, IT Corporation/Nuclear Sciences, Washington, D.C.*
Performed health physics consulting for government and commercial facilities in Internal and External Dosimetry; Radiation Monitoring; Environmental Monitoring; Instrumentation; Emergency Response and Preparedness; Site Decommissioning; Radioactive Waste Management; Radiation Risk Assessment; Training; Licensing and Regulatory Negotiations; and Non-ionizing Radiation

1986 - 1989 *Senior Health Physicist, IT Radiological Sciences Laboratory, Knoxville, Tennessee* Performed health physics consulting for government and commercial facilities in Internal and External Dosimetry; Radiation Monitoring; Environmental Monitoring; Applied Health Physics; Instrumentation; Radioactive Waste Management; Training; and Non-ionizing Radiation.

1983 - *1986* *Radiation Dosimetry Group Leader, Oak Ridge National Laboratory, Oak Ridge, Tennessee.* Responsible for internal and external dose assessment and programs for ORNL employees, visitors and contractors. Experience included Internal and External Dose Assessment; Monitoring Program Design and Implementation; Instrumentation Development; Site Characterizations; Personnel Management; and Training.

1978 - *1983* *Internal Dose Group Leader, Oak Ridge National Laboratory, Oak Ridge, Tennessee.* Responsible for development of the ORNL Whole Body Counter Facility for detection and quantification of the actinides in-vivo. Experience included: Internal Dose Assessment; Monitoring Program Design and Implementation; Instrumentation Development; Special Studies; Personnel Management; and Training.

1978 - *1986* *Adjunct Faculty, Oak Ridge Associated Universities, Oak Ridge, Tennessee.* Professional training courses and general classes in the following health physics and radiation protection areas: Internal Dose Assessment; In-vivo Monitoring and Bioassay Methodologies; Instrumentation, and Applied Health Physics.

1979 - *1980* *Health Physics and Dosimetry Task Group Member, President's Commission on the Accident at Three Mile Island, Washington, D.C.* Tasks included: Internal Dose Assessment from Whole Body Counting Results; Estimates of Source Term from in-plant Monitoring Systems; Atmospheric Dispersion Modeling and Population Dose Assessment; and Development of Health Physics Sequence of Events.

Professional Society Membership

American Academy of Health Physics (President, 1995; Executive Committee, 1995-1997; Chair of Strategic Planning Committee, 1997)
Health Physics Society
Baltimore-Washington Chapter - Health Physics Society (Treasurer, 1993-1994, Board of Directors, 1998-1999)
Sigma Xi - Scientific Research Society
American Bar Association, Section of Natural Resources, Energy, and Environmental Law
Environmental Law Institute

Publications

Over 30 professional publications; over 40 oral presentations; over 100 technical reports; more than 15 training courses taught.

Other Appointments/Awards

East Tennessee Chapter - Health Physics Society (President, 1986; President-Elect, 1985; Secretary, 1981-1982)

San Diego Chapter - Health Physics Society (Charter member)

American Board of Health Physics, Comprehensive Panel of Examiners, 1989-1993.

ASTM Task Group E-10.04.27 "Transuranic Wound Analysis"; 1986 to present

ANSI Standards Committee (ANSI N13.41) on Multiple Badging; 1986 to 1996 (Chairman, PlanCo-59 Working Group, 1990 to 1996)

ANSI Standards Committee (ANSI N13.39) on Internal Dosimetry Programs; 1994 to present

NCRP Scientific Committee 46-10, "Assessment of Occupational Exposures from Internal Emitters", 1989 to present.

Member of the Health Sciences Advisory Council for the School of Health Sciences, Purdue University, 1995 to 1998.

DOE/IAEA Whole Body Counter Intercalibration Committee (1980-1986)

Consultant to Knoxville Academy of Medicine, Mass Casualty Simulation (1984-1985)

Consultant to the National Cancer Institute to Evaluate Devices and Techniques to Determine Previous Radiation Exposure under Public Law 98-54 (Award for participation presented by Oak Ridge Associated Universities, April, 1988.)

Steering Committee Member, U. S. Department of Energy Task Group on the Education of Future Health Physicists - 1989 to 1991.

Technical reviewer and referee for *Health Physics*, *Nuclear Technology*, and *Radiation Protection Management*

IT Corporation *Distinguished Technical Associate* - June, 1992.

Alex J. Boerner - Technical Support and Peer Review

Professional Qualifications

Mr. Boerner has fifteen years of senior-level experience in nuclear and radiological activities with emphasis in the design and conduct of radiation surveys in both occupational and environmental settings. He also has extensive experience in training all levels of personnel about radiological topics. Mr. Boerner is actively involved in the areas of environmental monitoring, site decommissioning, program evaluations and development, and detection and quantification of low-levels of radioactivity.

Education

M.S., Radiation Biology, University of Tennessee, Knoxville, Tennessee; 1982
B.S., Biology, Augusta College, Augusta, Georgia; 1977

Certifications

Certified Health Physicist (Comprehensive), American Board of Health Physics, 1989
Recertified: 1993, 1997

Hazardous Materials Incident Response Operations (165.5) course (29 CFR 1910.120 OSHA Health and Safety Training for Operations in Hazardous Waste Sites), Roane State Community College, Institute for Environmental Health and Safety, in cooperation with the USEPA Office of Emergency and Remedial Response, Oak Ridge, Tennessee, 4/21 - 4/25/97). Updated through 1999.

Experience and Background

1997 - Present — *Senior Health Physicist, Integrated Environmental Management, Inc., Knoxville, Tennessee*. - Provides high-quality radiation protection services to commercial and government clients. As a member of the client's response team, works with clients to promote an understanding of what is required to achieve and/or maintain compliance in the eyes of all pertinent regulatory agencies, individually or jointly; develop an overall strategy for achieving compliance and reduce liabilities in a technically-sound, legally-defensible, and fiscally-conservative business manner; recommend specific solutions that are compatible with the client's operating philosophy; and provide insights into future regulatory issues and their impact as input to the client's long-range business planning and cost forecasting process.

1986 - 1996 — *Health Physics Instructor, Professional Training Programs, Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee.* - Instructed in approximately 200 training courses for a wide audience ranging from elementary, high school, and college students to NRC, NRC licensees, DOE, DOE contractors, EPA, DOD, state radiological health personnel, and other professionals in applied health physics. Developed curricula, coordinated and conducted classroom and laboratory/field

exercises for professional training courses and general classes in the following health physics and radiation protection areas: Applied Health Physics, Safe Use of Radionuclides, Air Sampling for Radioactive Materials, Environmental Monitoring for Radioactivity, Gamma Spectroscopy, Health Physics for the Industrial Hygienist, and Radiological Surveys in Support of Decommissioning. In addition:

- Managed and coordinated for several years the NRC's five-week "Health Physics and Radiation Protection" (HPRP) and one-week "Health Physics Engineering" (HPE) courses through the Office of State Programs in Rockville, Maryland and the Office of Analysis and Evaluation of Operational Data/Technical Training Center in Chattanooga, Tennessee.

- Developed, coordinated, and presented three special two-day "Radiological Surveys in Support of Decommissioning" courses for the NRC at offsite locations in Rockville, Maryland and King of Prussia, Pennsylvania.

- Conducted "Site Access Training" and "Site Access Refresher Training" for NRC inspectors in Bethesda, Maryland and Rockville, Maryland.

- Presented lectures in the one-week DOE-sponsored "Radiological Assessors Training (for DOE auditors and inspectors): Applied Radiological Control" in Oak Ridge, Tennessee, Albuquerque, New Mexico, and Las Vegas, Nevada. Served as team coordinator during a visit to and an assessment of the Nevada Test Site.

- Presented a series of lectures in the following DOE-sponsored courses: "Environmental Laws and Regulations", "Introduction to Radiation Protection of the Public and the Environment", "Radiological Control Manual for Managers Training" and "10 CFR 835" training.

- Presented several lectures in nuclear criticality safety training and "Train the Trainer" courses for Lockheed-Martin Y-12 and contractor employees.

- Assisted in special projects including the preparation and development of a DOE EH-74 Radiation Protection Topical Area study guide in support of the DOE Technical Qualification Program.

1983 - 1986 *Health Physics Team Leader, Radiological Site Assessment Program, Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee* - Planned environmental survey strategies and organized survey trips. Directed a team of health physics technicians in conducting environmental radiological surveys throughout the United States to quantify the nature and extent of radiological contamination at these sites. Reviewed survey data, interpreted results, and compared the results with applicable

standards to determine whether site decontamination efforts were successful in achieving applicable clean-up criteria. Prepared survey reports. Assisted with the development of equipment, procedures, and techniques for conducting surveys.

1982 - 1983 *Health Physics Technician, Radiological Site Assessment Program, Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee* - Conducted environmental radiological surveys throughout the United States to characterize the nature and extent of radiological contamination at sites and to perform certification surveys at sites where site decontamination efforts were completed.

1977 - 1979 *Health Physics Technician, Edwin I. Hatch Nuclear Power Plant, Georgia Power Company, Baxley, Georgia* - As an ANSI-qualified technician, designed and conducted surveys to determine the level of external and internal hazards associated with the operation and maintenance of a nuclear power generating station.

Professional Society Membership

Health Physics Society (Plenary member)
East Tennessee Chapter, Health Physics Society (President-elect, 1998-1999; Treasurer, 1990 - 1991; Chairman of Handbook Committee, 1988-89;Co-Chairman, Continuing Education Committee, 1988-1990; Area Representative, 1989; Co-Chairman, Picnic Committee,1988; Technical Tours Committee, 1984-1986)
Phi Kappa Phi National Honor Society (inactive)

Publications/Presentations

"Comprehensive Radiological Survey of the Niagara Falls Storage Site Off-Site Properties, Lewiston, New York", presented at the 29th Annual Meeting of the Health Physics Society, New Orleans, Louisiana, June,1984.

Author or co-author of approximately 20 technical reports for the NRC and DOE in the area of environmental site characterization and verification; numerous oral presentations; approximately 200 training courses taught.

Other Appointments/Awards

Member of the ORISE Radiation Emergency Assistance Center/Training Site (REAC/TS) Emergency Response Team (1986-1996)

Adjunct faculty instructor, Health Physics Technology Program, Roane State Community College, Harriman, Tennessee (1989-1996)

Member of DOE Safety and Health Task Force addressing concerns noted following a Technical Safety Appraisal (TSA) of the Martin Marietta Oak Ridge facilities (1989).

Appendix B - Instrument Records

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER INTERGRATED ENVIRONMENTAL MGT ORDER NO. 214833

Mfg. Ludlum Measurements, Inc. Model 2241 Serial No. 143562

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR151704

Cal. Date 16-Mar-98 Cal Due Date 16-Mar-99 Cal. Interval 1 Year Meterface 44-10

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °F RH 48 % Alt 695.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☐ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☐ Window Operation
☐ Audio ck. ☑ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC
☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 12/19/89.

Instrument Volt Set 1200 V Input Sens. 10 mV Det. Oper. 1200 V at 10 mV Threshold Dial Ratio ____ = ____ mV

COMMENTS:

Firmware: P-04-05 Cs137 check source s/n 3354 reads ≈23351 cpm using 6 sec counts and 235Kcpm using ratemeter with crystal end of probe placed flat against source with door open.

	Det #1 cpm
Deadtime:	no deadtime
Cal constant:	100e-2
Alert:	800kcpm
Alarm:	900kcpm

Overload checked but not set.

Gamma Calbration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
AUTO			
AUTO			
"			
"			
"			
"			
"			
"			
"			

*Uncertainty within ± 10% C.F. within ± 20%

All Range(s) Calibrated Electronically

Ratemeter Readout	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
	800K cpm		800 Kcpm
	200K cpm		200 Kcpm
	80K cpm		80.0Kcpm
	20K cpm		20.0Kcpm
	8K cpm		8.00Kcpm
	2K cpm		2.00 Kcpm
	800 cpm		0.80Kcpm
	200 cpm		0.20Kcpm

Scaler Readout	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
	800K cpm		80113 (0)
	200K cpm		20122 (0)
	80K cpm		8013 (0)
	20K cpm		1998 (0)
	8K cpm		802 (0)
	2K cpm		201 (0)
	800 cpm		80 (0)
	200 cpm		20 (0)

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of MIL-STD-45662A and ANSI N323-1978. State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ____ ☐ Beta S/N ____ ☑ Other Am241 ≈1.6μCi

☑ m 500 S/N 104535 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 956210389

Calibrated By: Rhonda Harris Date 16 Mar 98

Reviewed By: Armando DeLeon Date 16 Mar 98

FORM C22E 09/08/97

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR151704

Customer INTERGRATED ENVIRONMENTAL MGT Order #. 214833

Counter 2241 Serial No. 143562 Counter Input Sensitivity 10 mV

Count Time 60sec Distance Source to Detector surface

Other

High Voltage	Background	Isotope Am241 Size ≈1.6μC	Isotope Size	Isotope Size	Isotope Size
850	894	7833			
900	912	10103			
950	981	24 11155 ~~10947~~			
1000	969	11769			
1050	980	11708			
1100	917	11905			
1150	965	11892			
→ 1200	950	11876			
1250	990	11844			
1300	946	11981			
1350	992	12022			
1400	979	11971			
1450	1102	12117			

Signature Rhonda Harris Date 16 Mar 98

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER INTERGRATED ENVIRONMENTAL MGT ORDER NO. 214833

Mfg. Ludlum Measurements, Inc. Model 2241 Serial No. 119737

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR151705

Cal. Date 16-Mar-98 Cal Due Date 16-Mar-99 Cal. Interval 1 Year Meterface 44-10

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °F RH 48 % All 695.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☐ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☐ Window Operation
☐ Audio ck. ☑ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 12/19/89.

Instrument Volt Set 1150 V Input Sens. 10 mV Det. Oper. 1150 V at 10 mV Threshold Dial Ratio = mV

COMMENTS:

Firmware: P-04-05 Cs137 check source s/n3347 reads ≈21799cpm using 6 sec counts and ≈23kcpm using ratemeter with crystal end of probe placed flat against source with door open.

	Det #1 cpm
Deadtime:	no deadtime
Cal constant:	100e-2
Alert:	800kcpm
Alarm:	900kcpm

Overload checked but not set.

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
AUTO			
AUTO			
"			
"			
"			
"			
"			
"			
"			

*Uncertainty within ± 10% C.F. within ± 20%

All Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Ratemeter Readout	800K cpm		800Kcpm
	200K cpm		200Kcpm
	80K cpm		80.1Kcpm
	20K cpm		20.0Kcpm
	8K cpm		8.00Kcpm
	2K cpm		2.01Kcpm
	800 cpm		0.78Kcpm
	200 cpm		0.20Kcpm

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Scaler Readout	800K cpm		80081 (0)
	200K cpm		19949 (0)
	80K cpm		8009 (0)
	20K cpm		2008 (0)
	8K cpm		801 (0)
	2K cpm		200 (0)
	800 cpm		80 (0)
	200 cpm		20 (0)

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of MIL-STD-45662A and ANSI N323-1978. State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☐ Beta S/N ☑ Other Am241 ≈1.6µCi

☑ m 500 S/N 104535 ☐ Oscilloscope S/N ☑ Multimeter S/N 956210389

Calibrated By: Rhonda Hann Date 16 Mar 98

Reviewed By: Armand DeToro Date 16 Mar 98

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR151705

Customer INTERGRATED ENVIRONMENTAL MGT Order #. 214833

Counter 2241 Serial No. 119737 Counter Input Sensitivity 10 mV

Count Time 60 sec Distance Source to Detector surface

Other

High Voltage	Background	Isotope Am241 Size ≈1.6 μCi	Isotope Size	Isotope Size	Isotope Size
950	954	10852			
1000	912	11136			
1050	931	11226			
1100	929	11212			
→ 1150	914	11279			
1200	939	11222			
1250	957	11229			
1300	986	11132			
1350	1146	11525			

Signature Rhonda Harris Date 16 Mar 98

Appendix C - Daily Instrument Check Records

INTEGRATED ENVIRONMENTAL MANAGEMENT, INC.
EXPOSURE RATE SURVEY INSTRUMENT DATA SHEET

Project No. 94005.17	Detector		Meter		
Site Location/Background Location: SMC Newfield Instrument Office	Type: Ludlum 44-10	Serial No. 151101	Type: Ludlum 2241	Serial No: 143562	Operating Voltage: OK

Check Source Number	Radionuclide:	Calibration Activity and Date:
3788	Cs-137	1.24 uC 9/12/91

Date	Units	Start of Shift Background				End of Shift Background				Daily Response ~~uR/hr~~ cpm	Initials
		1	2	3	Avg.	1	2	3	Ave.		
9/14/98	cpm	6500	6300	6000	6,267	6300	6100	6200	6200	348,000	RMD
9/15	cpm	6400	6100	6500	6333	6200	6200	6500	6300	345,000	RMD
9/16	cpm	6100	6300	6500	6,300	~~6400~~ 6200 no	5900	6100	6067	350,000	RMD
9/17	cpm	5900	5700	5900	5830	6000	5900	5900	5933	341,000	RMD
9/18	cpm	6500	6100	6200	6,266	6100	6000	6200	6100	341,000	GJB

INTEGRATED ENVIRONMENTAL MANAGEMENT, INC.
EXPOSURE RATE SURVEY INSTRUMENT DATA SHEET

Project No. 94005	Detector		Meter		
Site Location/Background Location: SMC Newfield. Instrument Office	Type: Ludlum 44-10	Serial No. 151705	Type: Ludlum 2241	Serial No: 119737	Operating Voltage: OK

Check Source Number	Radionuclide:	Calibration Activity and Date:
3788	Cs-137	1.24 uC: 9/12/91

Date	Units	Start of Shift Background				End of Shift Background				Daily Response (uR/hr)	Initials
		1	2	3	Avg.	1	2	3	Ave.		
9/14/98	cpm	5300	5700	5300	5433	5900	6400	6000	6100	344,000	
9/15/98	cpm	6000	6200	5700	5967	5800	5600	5600	5667	341,000	
9/16/98	cpm	6000	5900	6600	6167	6100	5800	5900	5933	337,000	
9/17/98	cpm	6400	6300	5900	6200	6100	6000	6200	6100	337,000	
9/18/98	cpm	6300	6500	6200	6333	6200	6300	6100	6200	340,000	

INTEGRATED ENVIRONMENTAL MANAGEMENT, INC.
CONTAMINATION SURVEY INSTRUMENT DATA SHEET

Project No: 94005.05	Detector			Meter		
Site Location/Background Location: SMC New Field - Instrument Offic	Type: Ludlum 43-89	Serial No. 132118	Probe Area (cm²) ~~100~~ 126	Type: Ludlum 2224	Serial No: 119791	Operating Voltage: 0.8 kV
Check Source No: 3785	Check Source No:			Check Source No:		
Radionuclide: Th-230 / Activity: 6500dpm / Date: 9/18/91	Radionuclide:	Activity:	Date:	Radionuclide:	Activity:	Date:

Date	Start of Shift Background (cpm for a 1 minute count)								End of Shift Background (cpm for a 1 minute count)								Daily Source Check (α)		Daily Source Check (β)		MDA** - Scaler Mode (dpm)		Bat. OK	HV OK	Initials
	Alpha				Beta				Alpha				Beta				Source (cpm)	Eff.	Source (cpm)	Eff.	α	β			
	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.									
9/14	0	1	2	1	← N/A →				1	2	0	1	← N/A →				1074	0.165	N/A	N/A	35	N/A	✓	✓	BKD
9/15	1	2	1	1.3					0	1	1	0.7					1086	0.167			38		✓	✓	BKD
9/16	1	1	1	1					0	1	1	0.7					1102	0.17			34		✓	✓	JDM
9/17	1	0	1	0.7					1	2	1	1.3					1089	0.164			31		✓	✓	BKD
9/18	4	3	0	2.3					Not Performed - BKD →								1009	0.155	↓	↓	50	↓	✓	✓	GJB

** $MDA = \frac{2.71 + 4.65\sqrt{BKG_{avg} \times t}}{t \times E \times \frac{A}{100}}$

where MDA = the activity level (dpm/100 cm²), BKG_{avg} = the background count rate for this measurement type (cpm), t = the measurement duration (min), E = instrument efficiency, and A = probe area (cm²).

Appendix D - Survey Reports

SHIELDALLOY METALLURGICAL CORPORATION
RADIOLOGICAL SURVEY FORM
RSP-008

Survey Number 091598-01 Date of Survey 9/15/98 - 9/18/98

Survey Description:	Survey Performed by:
Release survey of haul road area after excavation. Performance of γ walkover survey, background sampling & verification soil sampling.	R.A. DUFF (Signature)
Drawing Attached: ☒ Yes ☐ No	R.A. DUFF (Print Name)

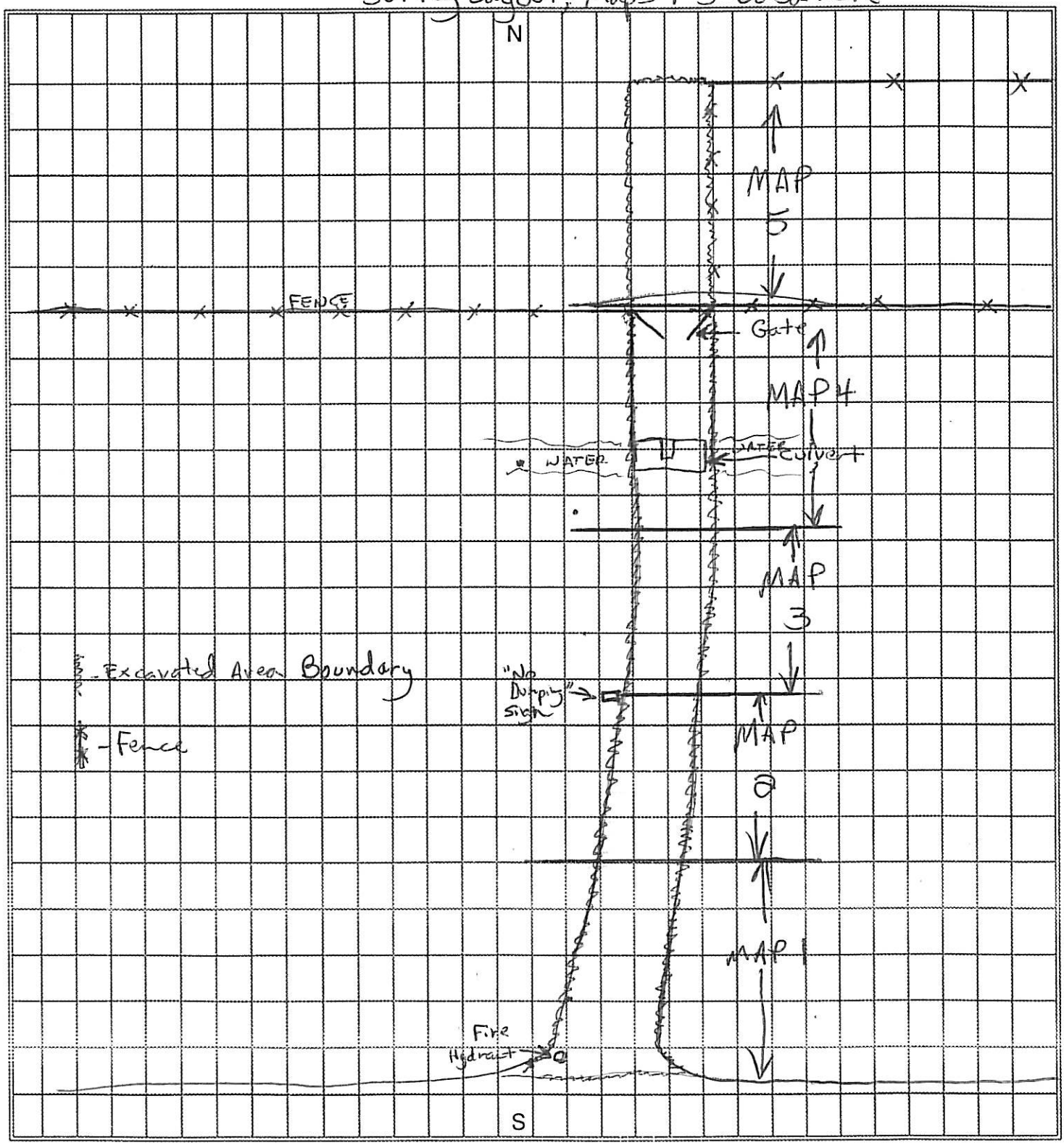
Instrument (1)	Instrument (2)	Instrument (3)
Model: Ludlum 2241 w/44-10 probe	Model: Ludlum 2241 w/44-10 probe	Model:
Serial No. 143562/151704	Serial No. 119737/151705	Serial No.
Calibration Due: 3/16/99	Calibration Due: 3/16/99	Calibration Due:
Efficiency N/A	Efficiency N/A	Efficiency
MDA N/A CF N/A BKG ~6000 cpm	MDA N/A CF N/A BKG ~6000 cpm	MDA CF BKG

Survey Point	Contamination Levels					Ambient Radiation Levels	Instrument Used	Comments and Additional Information
	Fixed (F) or Total (T)	Beta/gamma		Alpha		(microR/hour)		
		cpm/area	(dpm/100 cm²)	cpm/area	(dpm/100 cm²)			
9/15/98 - Conducted gridding of road area, conducted γ walkover of 100% of road & ~6' on either side of road for locations shown on maps # 1-4. Found several spots requiring further excavation, marked them w/orange paint.								
9/17/98 - Excavation subcontractor excavated marked locations, resurveyed those areas and areas disturbed by traffic. Noted area just South west of culvert (See Map #4) that showed elevated readings (up to 25k cpm) ~20' from road. Stopped excavation & backfilled w/clean soil so as not to disturb wetland area. Obtained soil samples & background soil samples at various locations. Surveyed area shown on Map #5.								Note:
9/18/98 - Obtained background soil samples & samples from haul road inside SMC fence.								

SHIELDALLOY METALLURGICAL CORPORATION
RADIOLOGICAL SURVEY MAP
RSP-008

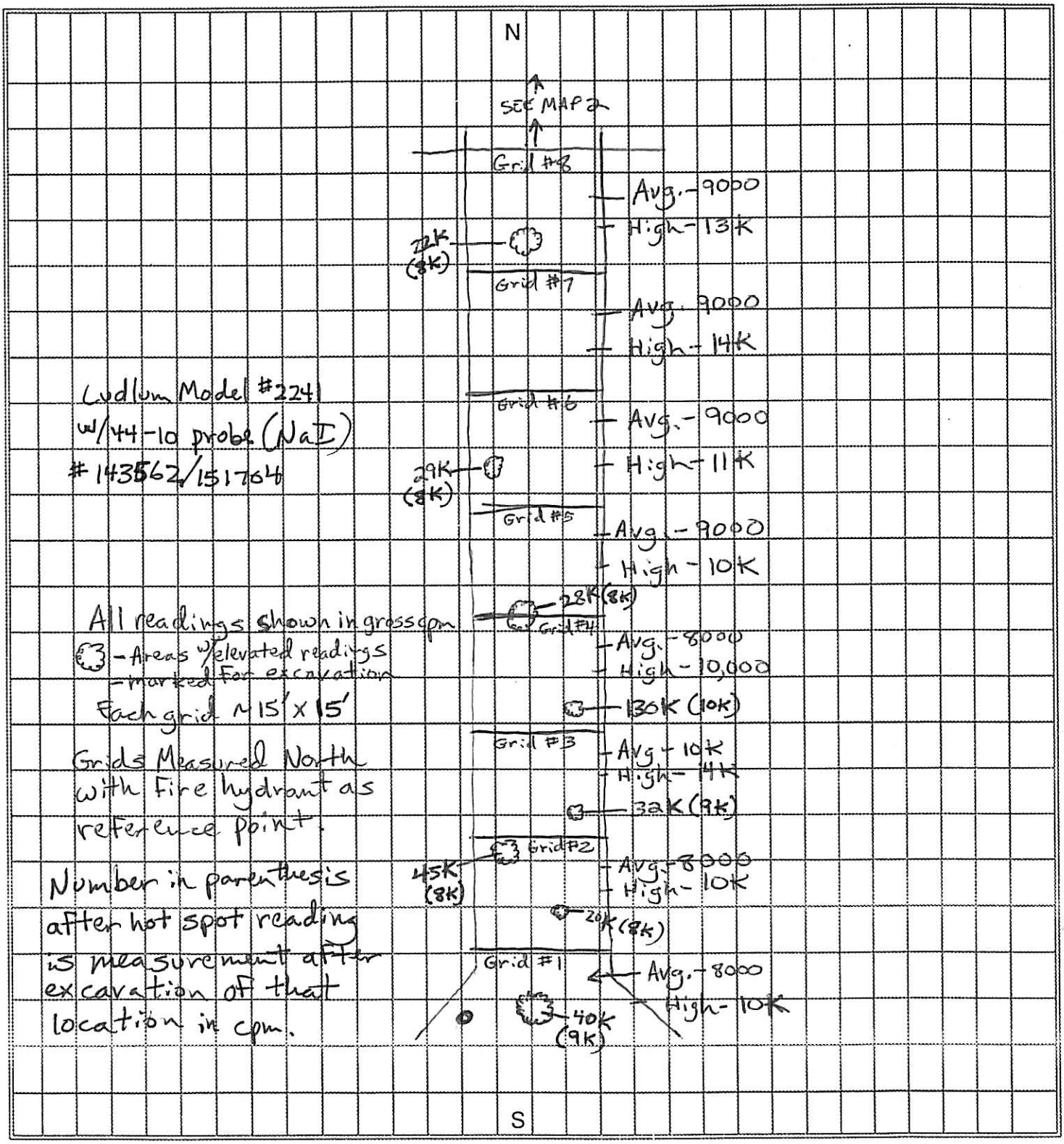
Survey Number 091598-01 Building/Area Haul Road Date of Survey 9/15/98 - 9/18/98

Survey Layout: Maps 1-5 Location



SHIELDALLOY METALLURGICAL CORPORATION
RADIOLOGICAL SURVEY MAP
RSP-008

Survey Number 091598-01 Map #1 Building/Area Haul Road Date of Survey 9/15/98 - 9/18/98

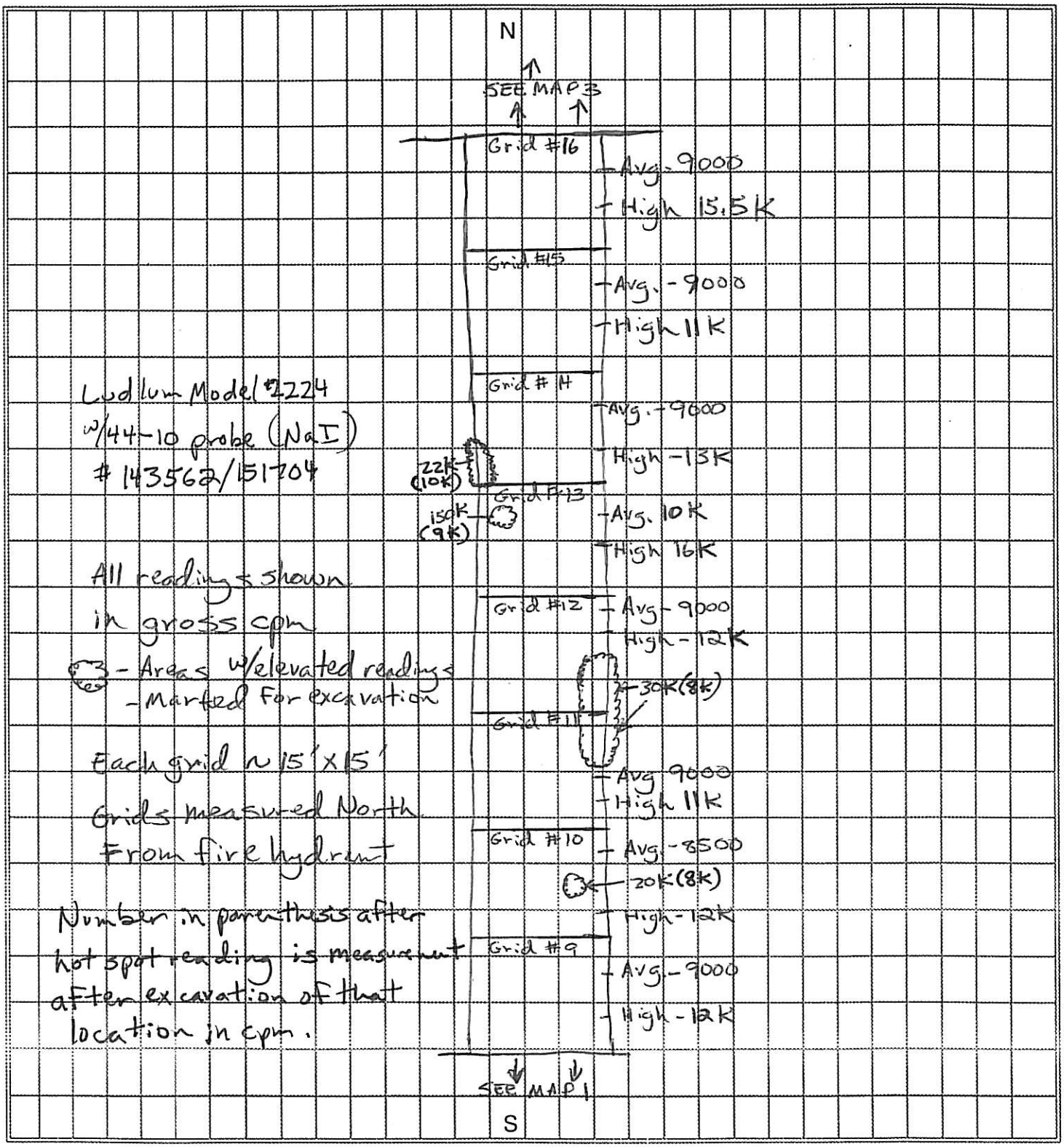


Ludlum Model #2241
w/44-10 probe (NaI)
#143562/151704

All readings shown in gross cpm
⬡ - Areas w/elevated readings - marked for excavation
Each grid ~15' x 15'
Grids Measured North with Fire hydrant as reference point.
Number in parenthesis after hot spot reading is measurement after excavation of that location in cpm.

SHIELDALLOY METALLURGICAL CORPORATION
RADIOLOGICAL SURVEY MAP
RSP-008

Survey Number 091598-01 Map #2 Building/Area Haul Road Date of Survey 9/15/98 - 9/18/98



Ludlum Model #2224
w/44-10 probe (NaI)
143562/151704

All readings shown in gross cpm

3 - Areas w/elevated readings - Marked For excavation

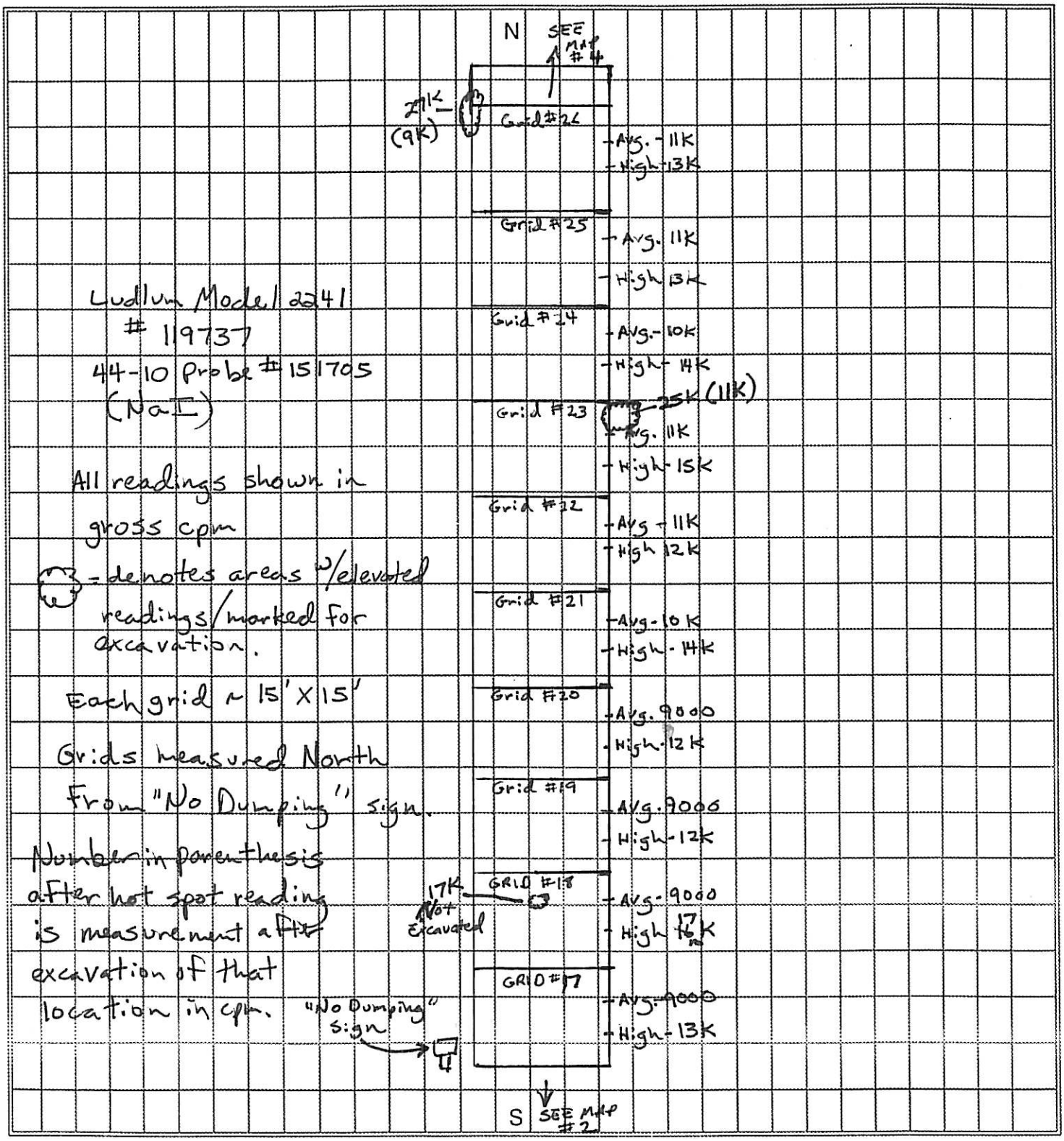
Each grid ~ 15' X 15'

Grids measured North From fire hydrant

Number in parenthesis after hot spot reading is measurement after excavation of that location in cpm.

SHIELDALLOY METALLURGICAL CORPORATION
RADIOLOGICAL SURVEY MAP
RSP-008

Survey Number 091598-01 Map 3 Building/Area Haul Road Date of Survey 9/15/98-9/18/98



Ludlum Model 2241
119737
44-10 Probe # 151705
(NaI)

All readings shown in gross cpm

= denotes areas w/elevated readings/marked for excavation.

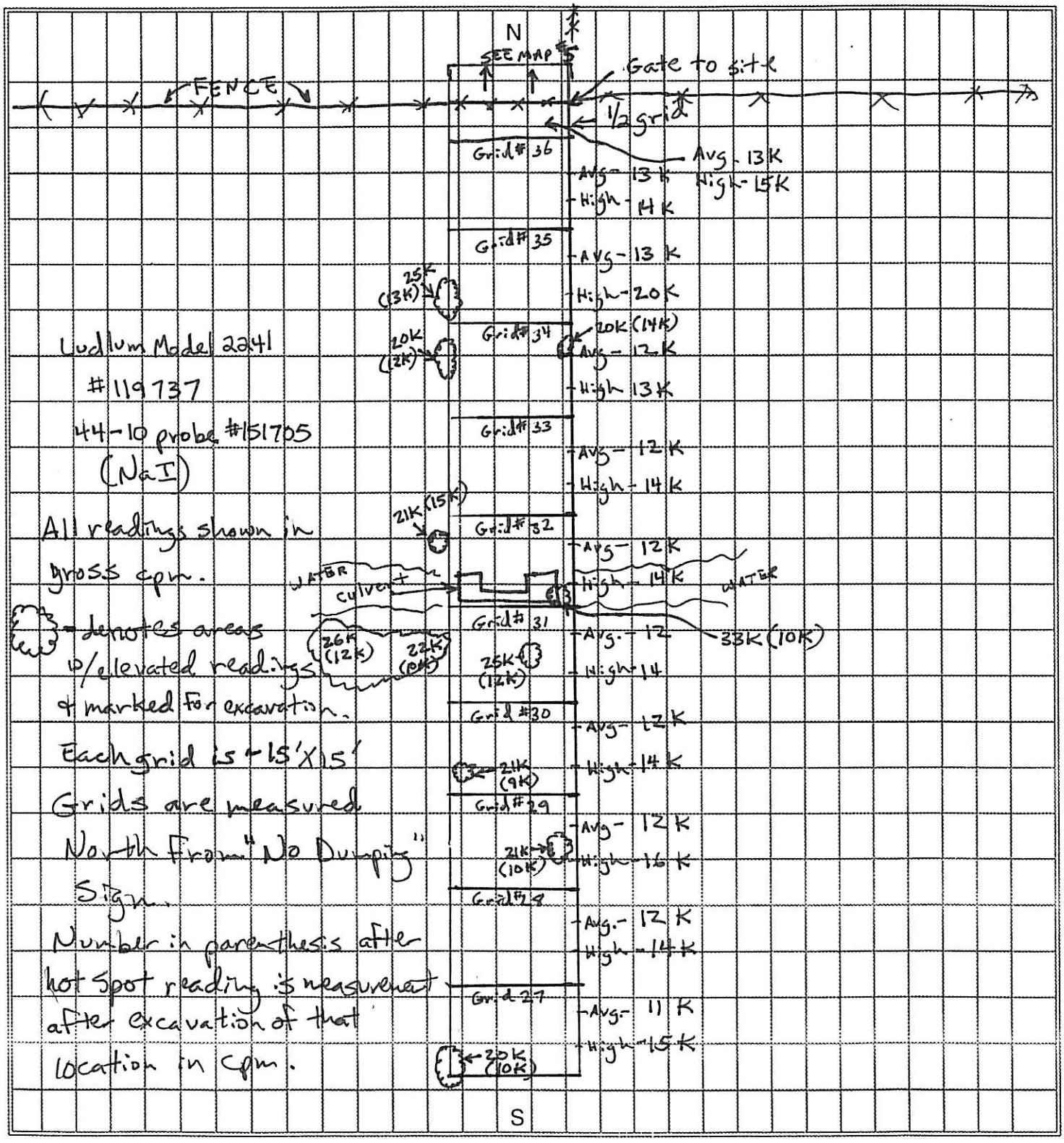
Each grid ~ 15' X 15'

Grids measured North From "No Dumping" sign.

Number in parenthesis after hot spot reading is measurement after excavation of that location in cpm.

SHIELDALLOY METALLURGICAL CORPORATION
RADIOLOGICAL SURVEY MAP
RSP-008

Survey Number 091598-01 Map 4 Building/Area Haul Road Date of Survey 9/15/98 - 9/18/98



Ludlum Model 2241
#119737
44-10 probe #151705
(NaI)

All readings shown in gross cpm.

= denotes areas of elevated readings & marked for excavation.

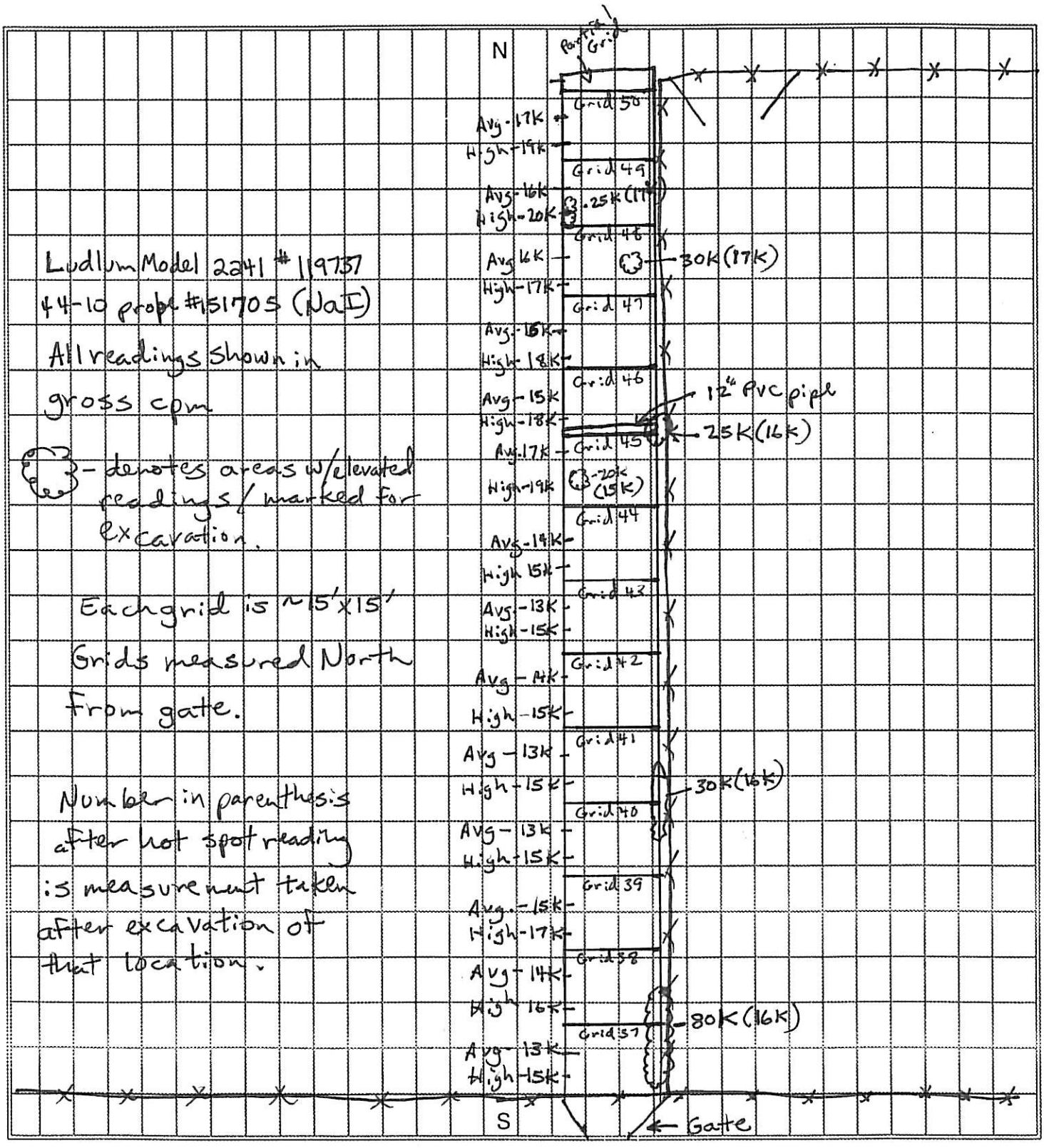
Each grid is 15' X 15'

Grids are measured North From "No Dumping" Sign.

Number in parenthesis after hot spot reading is measurement after excavation of that location in cpm.

SHIELDALLOY METALLURGICAL CORPORATION
RADIOLOGICAL SURVEY MAP
RSP-008

Survey Number 091598-01 MAP #5 Building/Area Haul Road Date of Survey 9/15/98 - 9/18/98



Ludlum Model 2241 # 119737
44-10 probe #151705 (NaI)

All readings shown in gross cpm

3 - denotes areas w/elevated readings / marked for excavation.

Each grid is ~15'x15'

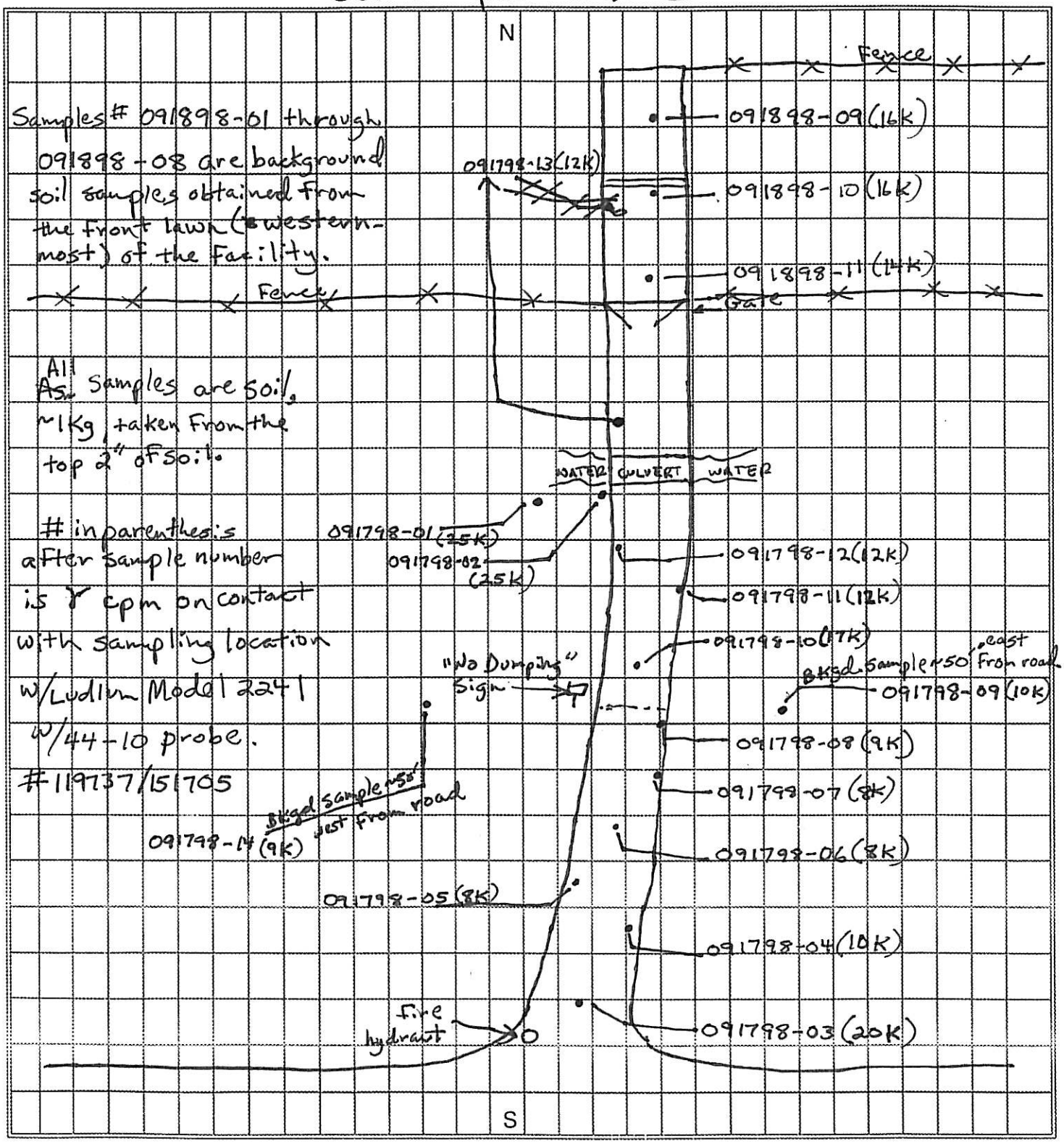
Grids measured North from gate.

Number in parenthesis after hot spot reading is measurement taken after excavation of that location.

SHIELDALLOY METALLURGICAL CORPORATION
RADIOLOGICAL SURVEY MAP
RSP-008

Survey Number 091598-01 Building/Area Haul Road Date of Survey 9/17/98 - 9/18/98

Soil Sample Locations



Outreach Laboratory
311 North Aspen
Broken Arrow, Ok 74012
(918) 251-2515
FAX (918) 251-0008

RECEIVED 10/30/98

Lab Project Number:	980905
Client:	IEM
Client Project Number:	94005.17
Site Description:	Shieldalloy
Site Location:	Haul Road
Date Submitted:	Sep 21, 1998
Date Reported:	10/8/98
Page:	1 of 2

LAB ID	CLIENT ID	SAMPLE DATE	MATRIX	Ac-228 pCi/g			MDA	Bi-214 pCi/g			MDA
~~980905-01~~	~~091798- 001~~	~~9/17/98~~	~~soil~~	~~1.0~~	~~+/-~~	~~0.5~~	~~0.8~~	~~0.7~~	~~+/-~~	~~0.2~~	~~0.3~~
~~980905-02~~	~~091798- 002~~	~~9/17/98~~	~~soil~~	~~1.5~~	~~+/-~~	~~0.6~~	~~0.8~~	~~0.8~~	~~+/-~~	~~0.7~~	~~0.5~~
980905-03	091798- 003	9/17/98	soil	1.0	+/-	0.4	0.8	0.7	+/-	0.2	0.3
980905-04	091798- 004	9/17/98	soil	0.6	+/-	0.5	0.6	1.0	+/-	0.3	0.3
980905-05	091798- 005	9/17/98	soil	1.0	+/-	0.6	0.9	0.6	+/-	0.2	0.2
980905-06	091798- 006	9/17/98	soil	0.9	+/-	0.5	0.6	0.8	+/-	0.3	0.3
980905-07	091798- 007	9/17/98	soil	0.9	+/-	0.5	0.6	0.6	+/-	0.2	0.3
980905-08	091798- 008	9/17/98	soil	1.0	+/-	0.5	0.7	1.1	+/-	0.4	0.4
980905-09	091798- 009	9/17/98	soil	0.8	+/-	0.7	1.0	1.0	+/-	0.6	0.7
980905-10	091798- 010	9/17/98	soil	0.9	+/-	0.6	0.8	3.8	+/-	0.8	0.5
980905-11	091798- 011	9/17/98	soil	0.5	+/-	0.5	0.8	0.4	+/-	0.4	0.6
980905-12	091798- 012	9/17/98	soil	0.9	+/-	0.7	1.0	0.6	+/-	0.4	0.6
980905-13	091798- 013	9/17/98	soil	1.2	+/-	0.8	1.0	0.8	+/-	0.4	0.5
980905-14	091798- 014	9/17/98	soil	0.9	+/-	0.6	0.9	0.6	+/-	0.4	0.5
980905-16	091898- 01	9/18/98	soil	1.8	+/-	0.8	0.9	1.7	+/-	0.5	0.5
980905-17	091898- 02	9/18/98	soil	1.4	+/-	0.9	1.3	1.0	+/-	0.5	0.5
980905-18	091898- 03	9/18/98	soil	0.9	+/-	0.5	0.6	0.8	+/-	0.4	0.5
980905-19	091898- 04	9/18/98	soil	1.4	+/-	0.9	0.9	0.6	+/-	0.4	0.5
980905-20	091898- 05	9/18/98	soil	0.6	+/-	0.6	0.9	0.6	+/-	0.3	0.5
980905-21	091898- 06	9/18/98	soil	0.6	+/-	0.7	1.0	0.5	+/-	0.4	0.5
980905-22	091898- 07	9/18/98	soil	1.2	+/-	0.4	0.9	0.5	+/-	0.4	0.7
980905-23	091898- 08	9/18/98	soil	0.6	+/-	0.6	1.0	0.9	+/-	0.4	0.5
980905-24	091898- 09	9/18/98	soil	1.8	+/-	0.8	0.8	0.8	+/-	0.4	0.5
980905-25	091898- 10	9/18/98	soil	0.1	+/-	0.5	0.9	0.1	+/-	0.3	0.5
980905-26	091898- 11	9/18/98	soil	0.2	+/-	0.4	0.8	0.4	+/-	0.3	0.5

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SHIELDALLOY METALLURGICAL CORPORATION

P.O. BOX 768, 12 WEST BOULEVARD
NEWFIELD, N.J. 08344 (609)692–4200

Project No. IEM 94005.~~05~~17

Purchase Order IEM

Sampler: (Print Name) Alan Duff

Chain of Custody Tape No. N/A

Sample No./ Identification	Collection Date	Collection Time	Preserv.	Lab Sample Number	Sample Matrix (Liquid, Sludge, etc.)	ANALYSES: Gamma Spectroscopy						Number of Containers/ REMARKS
091798-001	9/17/98	1300	None		So:1	✓						Area w of haul Rd.
091798-002		1305				✓						↓
091798-003		1400				✓						Haul Road So:1
091798-004		1410				✓						
091798-005		1420				✓						
091798-006		1440				✓						
091798-007		1445				✓						
091798-008		1450				✓						
091798-009		1455				✓						
091798-010		1500		N/A	N/A	✓		N/A	N/A		N/A	N/A BKG

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
1. [signature] 9/18	9/18/98	1430	[signature]	9/21/98	1150
2.					
3.					
4.					
5.					

Sample Disposal Method: Return to Shieldalloy

Disposed of by: (Signature) | Date | Time

SAMPLE COLLECTOR/WITNESS (Signature) [signature]

ANALYTICAL LABOARATORY AND CONTACT: Outreach- Ron Eidson

Draft report to Carol Berger within 20 days
SEE ATTACHED LETTER

№ 001676

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SHIELDALLOY METALLURGICAL CORPORATION
P.O. BOX 768, 12 WEST BOULEVARD
NEWFIELD, N.J. 08344 (609)692-4200

Project No. IEM 94005.17 (~~.05~~)

Purchase Order: IEM

Sampler: (Print Name) R. Alan DuFF

Chain of Custody Tape No.: N/A

Sample No./ Identification	Collection Date	Collection Time	Preserv.	Lab Sample Number	Sample Matrix (Liquid, Sludge, etc.)	Gamma Spectroscopy	Total Uranium	Thorium Isotopic				Number of Containers/ REMARKS
091798-011	9/17/98	1510	None		So.	✓						Haul Rd Soil
091798-012	9/17/98	1515				✓						
091798-013	9/17/98	~~1530~~ 1535				✓						
091798-014	9/17/98	1530				✓						
091798-015	9/17/98	0900				✓	✓	✓				Landfill Soil
091898-01	9/18/98	1115				✓						Front Lawn
091898-02	9/18/98	1120				✓						
091898-03	9/18/98	1125				✓						
091898-04	9/18/98	1130				✓						
091898-05	9/18/98	1135				✓						

	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
1.		9/18/98	1430		9/21/98	1500
2.						
3.						
4.						
5.						

Sample Disposal Method: Return to Shieldalloy

Disposed of by: (Signature) | Date | Time

SAMPLE COLLECTOR/WITNESS (Signature)

ANALYTICAL LABOARATORY AND CONTACT: Edson - Outreach

№ 001677

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SHIELDALLOY METALLURGICAL CORPORATION

P.O. BOX 768, 12 WEST BOULEVARD
NEWFIELD, N.J. 08344 (609)692–4200

Project No. 94005.17

Purchase Order IEM

Sampler: (Print Name) R. Alan DUFF

Chain of Custody Tape No. N/A

Sample No./ Identification	Collection Date	Collection Time	Preserv.	Lab Sample Number	Sample Matrix (Liquid, Sludge, etc.)	ANALYSES: Gamma Spec.						Number of Containers/ REMARKS
091898-06	9/18/98	1140	None		Soil	✓						Front Lawn Soil
091898-07	9/18/98	1145	↓		↓	✓						↓
091898-08	9/18/98	1150				✓						Haul Rd - Ins. de Fence
091898-09	9/18/98	1315				✓						↓
091898-10	9/18/98	1324				✓						
091898-11	9/18/98	1337	↓		↓	✓						

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
1.	9/18/98	1430		9/21/98	1400
2.					
3.					
4.					
5.					

Sample Disposal Method: Return to Shieldalloy

Disposed of by: (Signature) | Date | Time

SAMPLE COLLECTOR/WITNESS (Signature)

ANALYTICAL LABOARATORY AND CONTACT: Outreach - Ron Eidson

№ 001678

Appendix E - Technical Basis for Instrument Response

IEM
Integrated Environmental Management, Inc.

Project No: 94005.17		Page 1 of ___
Subject: Instrument Conversion Factor		
Performed by: CDBurgw	Date: 9/4/98	
Checked by:	Date:	

ASSUMPTIONS

1. INST. EFFICIENCY = $\frac{900 \text{ cpm}}{\mu R/hr}$ = E [Ludlum - model 224 1/44-10]

2. RELEASE CRITERION = 15 μR/hr above B/G = C [CDBurgw 9/1/98]

CALCULATION

CF = C * I

= $15 \frac{\mu R}{hr} * \frac{900 \text{ cpm}}{\mu R/hr}$

= 13,500 cpm

IEM
Integrated Environmental Management, Inc.

Project No: 94005.17	Page 1 of ___
Subject: Hanford Road – Site Parameters	
Performed by: (illegible)	Date: 9-15-98
Checked by: G. Boerner	Date: 10/20/98

ASSUMPTIONS

1. RELEASE CRITERION = 15 μR/hr @ 2cm (U+Th) [IEM - 9/1/93 Letter]

2. WEIGHTED cpm / μR/hr [MARSSIM TABLE 6.7]

Th-232 + d = 830

U_{NAT} = 3790

→ BTP = 2.5 pCi/gm ^{232}Th, ^{228}Th, ^{238}U, ^{234}U

3. $\frac{U}{Th} = \frac{1}{1}$

CALCULATION

$$\left(0.5 \times \frac{830\ cpm}{\mu R/hr} + 0.5 \times \frac{3790\ cpm}{\mu R/hr}\right) \times \frac{15\ \mu R}{hr} = 34{,}650\ cpm$$

SCAN RATE = 6.5 m/sec

DIAMETER AREA MEASURED = 0.56 mm } × i = 0.5 / 0.56 = 0.89 sec

$$B_i = 8000\ \frac{cpm}{m} \times 0.89\ sec \times \frac{1\ m}{60} = 118.7\ (counts)$$

$$MDCR = d' \times \sqrt{B_i} = 1.38 \times \sqrt{118.7} \times \frac{60s}{m} = 902.1\ \frac{c}{m}$$

If surveyor is 50% efficient at detecting elevated cts (MARSSIM p. 6-45)

$$MDCR = \frac{902.1}{\sqrt{0.5}} = 1276\ \frac{c}{m}$$

Appendix F - Wilcoxon Rank Sum Test Results

Data Set for Haul Road Wilcoxon Rank Sum Test

Number	Type	Sample ID		Th-228	Th-232	Th-230	U-234	U-238
1	S	091798-001		1	1	0.7	0.7	0.7
2	S	091798-002		1.5	1.5	3.3	3.3	3.3
3	S	091798-003		1	1	0.7	0.7	0.7
4	S	091798-004		0.6	0.6	1	1	1
5	S	091798-005		1	1	0.6	0.6	0.6
6	S	091798-006		0.9	0.9	0.8	0.8	0.8
7	S	091798-007		0.9	0.9	0.6	0.6	0.6
8	S	091798-008		1	1	1.1	1.1	1.1
9	S	091798-009		0.8	0.8	1	1	1
10	S	091798-010		0.9	0.9	3.6	3.6	3.6
11	S	091798-011		0.5	0.5	0.4	0.4	0.4
12	S	091798-012		0.9	0.9	0.6	0.6	0.6
13	S	091798-013		1.2	1.2	0.8	0.8	0.8
14	S	091798-014		0.9	0.9	0.6	0.6	0.6
15	S	091898-09		1.8	1.8	0.8	0.8	0.8
16	S	091898-10		0.1	0.1	0.1	0.1	0.1
17	S	091898-11		0.2	0.2	0.4	0.4	0.4
18	R	980715-15	IEM	0.900	0.900	0.500	0.500	0.500
19	R	980715-16	IEM	0.300	1.100	0.200	0.200	0.200
20	R	091898-01	IEM	1.800	1.800	1.700	1.700	1.700
21	R	091898-02	IEM	1.400	1.400	1.000	1.000	1.000
22	R	091898-03	IEM	0.900	0.900	0.800	0.800	0.800
23	R	091898-04	IEM	1.400	1.400	0.600	0.600	0.600
24	R	091898-05	IEM	0.600	0.600	0.600	0.600	0.600
25	R	091898-06	IEM	0.600	0.600	0.500	0.500	0.500
26	R	091898-07	IEM	1.200	1.200	0.500	0.500	0.500
27	R	091898-08	IEM	0.600	0.600	0.900	0.900	0.900
28	R	S7	NRC	0.290	0.330	0.900	0.900	0.900
29	R	ORAU-1	ORAU	0.300	0.300	1.300	1.300	1.300
30	R	ORAU-2	ORAU	0.500	0.500	0.400	0.400	0.400
31	R	ORAU-3	ORAU	0.100	0.100	0.300	0.300	0.300
32	R	ORAU-4	ORAU	0.100	0.100	0.300	0.300	0.300
33	R	ORAU-5	ORAU	0.400	0.400	0.400	0.400	0.400
34	R	ORAU-6	ORAU	0.500	0.500	0.400	0.400	0.400
35	R	ORAU-7	ORAU	0.600	0.600	0.800	0.800	0.800
36	R	ENSR-1	ENSR	1.480	1.480	0.830	0.830	0.830
37	R	ENSR-2		0.280	0.280	1.380	1.380	1.380

WRS Test - Haul Road Soil Samples

WRS - Th-232 **Alpha = 0.05** **DCGL (pCi/g) = 2.50**

Number	Data	Area	Adjusted Data	Ranks	Ref. Area Ranks
16	0.1	S	0.100	1.0	0
17	0.2	S	0.200	2.0	0
11	0.5	S	0.500	3.0	0
4	0.6	S	0.600	4.0	0
9	0.8	S	0.800	5.0	0
10	0.9	S	0.900	8.0	0
12	0.9	S	0.900	8.0	0
14	0.9	S	0.900	8.0	0
6	0.9	S	0.900	8.0	0
7	0.9	S	0.900	8.0	0
3	1	S	1.000	12.5	0
1	1	S	1.000	12.5	0
8	1	S	1.000	12.5	0
5	1	S	1.000	12.5	0
13	1.2	S	1.200	15.0	0
2	1.5	S	1.500	16.0	0
15	1.8	S	1.800	17.0	0
16	0.100	R	2.600	18.5	18.5
17	0.100	R	2.600	18.5	18.5
18	0.280	R	2.780	20.0	20
19	0.300	R	2.800	21.0	21
20	0.330	R	2.830	22.0	22
21	0.400	R	2.900	23.0	23
22	0.500	R	3.000	24.5	24.5
23	0.500	R	3.000	24.5	24.5
24	0.600	R	3.100	27.5	27.5
25	0.600	R	3.100	27.5	27.5
26	0.600	R	3.100	27.5	27.5
27	0.600	R	3.100	27.5	27.5
1	0.900	R	3.400	30.5	30.5
2	0.900	R	3.400	30.5	30.5
3	1.100	R	3.600	32.0	32
4	1.200	R	3.700	33.0	33
5	1.400	R	3.900	34.5	34.5
6	1.400	R	3.900	34.5	34.5
7	1.480	R	3.980	36.0	36
8	1.800	R	4.300	37.0	37

Sum **703.0** **550.0**

CL=434

WRS Test - Haul Road Soil Samples

WRS - Th-228 **Alpha = 0.05** **DCGL (pCi/g) = 2.50**

Number	Data	Area	Adjusted Data	Ranks	Ref. Area Ranks
16	0.1	S	0.100	1.0	0
17	0.2	S	0.200	2.0	0
11	0.5	S	0.500	3.0	0
4	0.6	S	0.600	4.0	0
9	0.8	S	0.800	5.0	0
10	0.9	S	0.900	8.0	0
12	0.9	S	0.900	8.0	0
14	0.9	S	0.900	8.0	0
7	0.9	S	0.900	8.0	0
6	0.9	S	0.900	8.0	0
1	1	S	1.000	12.5	0
5	1	S	1.000	12.5	0
8	1	S	1.000	12.5	0
3	1	S	1.000	12.5	0
13	1.2	S	1.200	15.0	0
2	1.5	S	1.500	16.0	0
15	1.8	S	1.800	17.0	0
32	0.100	R	2.600	18.5	18.5
31	0.100	R	2.600	18.5	18.5
37	0.280	R	2.780	20.0	20
28	0.290	R	2.790	21.0	21
29	0.300	R	2.800	22.5	22.5
19	0.300	R	2.800	22.5	22.5
33	0.400	R	2.900	24.0	24
30	0.500	R	3.000	25.5	25.5
34	0.500	R	3.000	25.5	25.5
25	0.600	R	3.100	28.5	28.5
24	0.600	R	3.100	28.5	28.5
35	0.600	R	3.100	28.5	28.5
27	0.600	R	3.100	28.5	28.5
22	0.900	R	3.400	31.5	31.5
18	0.900	R	3.400	31.5	31.5
26	1.200	R	3.700	33.0	33
23	1.400	R	3.900	34.5	34.5
21	1.400	R	3.900	34.5	34.5
36	1.480	R	3.980	36.0	36
20	1.800	R	4.300	37.0	37

Sum **703.0** **550.0**

CL=434

WRS Test - Haul Road Soil Samples

WRS - U-234 **Alpha = 0.05** **DCGL (pCi/g) = 2.50**

Number	Data	Area	Adjusted Data	Ranks	Ref. Area Ranks
16	0.1	S	0.100	1.0	0
11	0.4	S	0.400	2.5	0
17	0.4	S	0.400	2.5	0
7	0.6	S	0.600	5.5	0
14	0.6	S	0.600	5.5	0
12	0.6	S	0.600	5.5	0
5	0.6	S	0.600	5.5	0
1	0.7	S	0.700	8.5	0
3	0.7	S	0.700	8.5	0
13	0.8	S	0.800	11.0	0
15	0.8	S	0.800	11.0	0
6	0.8	S	0.800	11.0	0
9	1	S	1.000	13.5	0
4	1	S	1.000	13.5	0
8	1.1	S	1.100	15.0	0
19	0.200	R	2.700	16.0	16
31	0.300	R	2.800	17.5	17.5
32	0.300	R	2.800	17.5	17.5
34	0.400	R	2.900	20.0	20
33	0.400	R	2.900	20.0	20
30	0.400	R	2.900	20.0	20
25	0.500	R	3.000	23.0	23
26	0.500	R	3.000	23.0	23
18	0.500	R	3.000	23.0	23
23	0.600	R	3.100	25.5	25.5
24	0.600	R	3.100	25.5	25.5
2	3.3	S	3.300	28.0	0
35	0.800	R	3.300	28.0	28
22	0.800	R	3.300	28.0	28
36	0.830	R	3.330	30.0	30
27	0.900	R	3.400	31.5	31.5
28	0.900	R	3.400	31.5	31.5
21	1.000	R	3.500	33.0	33
10	3.6	S	3.600	34.0	0
29	1.300	R	3.800	35.0	35
37	1.380	R	3.880	36.0	36
20	1.700	R	4.200	37.0	37

Sum **703.0** **521.0**

CL=434

WRS Test - Haul Road Soil Samples

WRS - U-238 **Alpha = 0.05** **DCGL (pCi/g) = 2.50**

Number	Data	Area	Adjusted Data	Ranks	Ref. Area Ranks
16	0.1	S	0.100	1.0	0
11	0.4	S	0.400	2.5	0
17	0.4	S	0.400	2.5	0
7	0.6	S	0.600	5.5	0
14	0.6	S	0.600	5.5	0
12	0.6	S	0.600	5.5	0
5	0.6	S	0.600	5.5	0
1	0.7	S	0.700	8.5	0
3	0.7	S	0.700	8.5	0
13	0.8	S	0.800	11.0	0
15	0.8	S	0.800	11.0	0
6	0.8	S	0.800	11.0	0
9	1	S	1.000	13.5	0
4	1	S	1.000	13.5	0
8	1.1	S	1.100	15.0	0
19	0.200	R	2.700	16.0	16
31	0.300	R	2.800	17.5	17.5
32	0.300	R	2.800	17.5	17.5
34	0.400	R	2.900	20.0	20
33	0.400	R	2.900	20.0	20
30	0.400	R	2.900	20.0	20
25	0.500	R	3.000	23.0	23
26	0.500	R	3.000	23.0	23
18	0.500	R	3.000	23.0	23
23	0.600	R	3.100	25.5	25.5
24	0.600	R	3.100	25.5	25.5
2	3.3	S	3.300	28.0	0
35	0.800	R	3.300	28.0	28
22	0.800	R	3.300	28.0	28
36	0.830	R	3.330	30.0	30
27	0.900	R	3.400	31.5	31.5
28	0.900	R	3.400	31.5	31.5
21	1.000	R	3.500	33.0	33
10	3.6	S	3.600	34.0	0
29	1.300	R	3.800	35.0	35
37	1.380	R	3.880	36.0	36
20	1.700	R	4.200	37.0	37

Sum **703.0** **521.0**

CL=434

WRS Test - Haul Road Soil Samples

WRS - Th-230 **Alpha = 0.05** **DCGL (pCi/g) = 2.50**

Number	Data	Area	Adjusted Data	Ranks	Ref. Area Ranks
16	0.1	S	0.100	1.0	0
11	0.4	S	0.400	2.5	0
17	0.4	S	0.400	2.5	0
7	0.6	S	0.600	5.5	0
14	0.6	S	0.600	5.5	0
12	0.6	S	0.600	5.5	0
5	0.6	S	0.600	5.5	0
1	0.7	S	0.700	8.5	0
3	0.7	S	0.700	8.5	0
13	0.8	S	0.800	11.0	0
15	0.8	S	0.800	11.0	0
6	0.8	S	0.800	11.0	0
9	1	S	1.000	13,5	0
4	1	S	1.000	13.5	0
8	1.1	S	1.100	15.0	0
19	0.200	R	2.700	16.0	16
31	0.300	R	2.800	17.5	17.5
32	0.300	R	2.800	17.5	17.5
34	0.400	R	2.900	20.0	20
33	0.400	R	2.900	20.0	20
30	0.400	R	2.900	20.0	20
25	0.500	R	3.000	23.0	23
26	0.500	R	3.000	23.0	23
18	0.500	R	3.000	23.0	23
23	0.600	R	3.100	25.5	25.5
24	0.600	R	3.100	25.5	25.5
2	3.3	S	3.300	28.0	0
35	0.800	R	3.300	28.0	28
22	0.800	R	3.300	28.0	28
36	0.830	R	3.330	30.0	30
27	0.900	R	3.400	31.5	31.5
28	0.900	R	3.400	31.5	31.5
21	1.000	R	3.500	33.0	33
10	3.6	S	3.600	34.0	0
29	1.300	R	3.800	35.0	35
37	1.380	R	3.880	36.0	36
20	1.700	R	4.200	37.0	37

Sum **689.5** **521.0**

CL=434

This report was prepared under the direction of
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