VISTA Technologies, Inc.
Radiation Safety Program

PROCEDURE - 15

MONITORING AND SURVEYING

1019 Central Parkway North, Suite 115
San Antonio, Texas 78232
210-494-4282

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ABBREVIATIONS AND ACRONYMS

α	-	Alpha
ß	-	Beta
γ	-	Gamma
μ	-	Micro
^{241}Am	-	Americium-241
^{137}Ce	-	Cesium-137
^{234}Pa	-	Protactinium-234
^{210}Pb	-	Lead-210
^{210}Po	-	Polonium-210
^{214}Po	-	Polonium-214
^{218}Po	-	Polonium-218
^{232}Pu	-	Plutonium-232
^{226}Ra	-	Radium-226
^{228}Ra	-	Radium-228
^{219}Rn	-	Radon-219 (Actinium Series)
^{220}Rn	-	Radon-220 (Thorium Series)
^{222}Rn	-	Radon-222 (Uranium Series)
^{89}Sr	-	Strontium-89
^{90}Sr	-	Strontium-90
^{230}Th	-	Thorium-230
^{232}Th	-	Natural Thorium
^{238}U	-	Uranium-238
μCi	-	MicroCurie
μCi/hr	-	MicroCuries per hour
μCi/ml	-	MicroCuries per milliliter
μM	-	Micrometer
μR/hr	-	MicroRoentgen per hour
μg/mg	-	Microgram per milligram
ALARA	-	As low as reasonably achievable
ALI	-	Annual limit on intake
ANSI	-	American National Standards Institute
APR	-	Air-purifying respirator
Bq	-	Becquerel
Bq/m^3	-	Becquerels per cubic meter of air
BZ	-	Breathing Zone
C	-	Coulomb
C/kg	-	Coulombs per kilogram
CDE	-	Committed Dose Equivalent
CEDE	-	Committed Effective Dose Equivalent

CFR	-	Code of Federal Regulations
Ci	-	Curie
CIH	-	Certified Industrial Hygienist
CFM	-	Cubic feet per minute
CLIA	-	Clinical Laboratories Improvement Act
CLP	-	Contract Laboratory Program
cm	-	Centimeter
cm/sec	-	Centimeters per second
cpm	-	Counts per minute
CPR	-	Cardiopulmonary resuscitation
CSE	-	Certified Safety Executive
(D)	-	Duplicate count
DAC	-	Derived air concentration
DAC-h	-	DAC hours
DCA	-	Double Contingency Analysis
DDE	-	Deep Dose Equivalent
DI	-	De-ionized water
DOT	-	U.S. Department of Transportation
dm^2	-	Square Decimeter; one square decimeter equals 100 square centimeters
dpm	-	Disintegrations per minute
dpm/cm^2	-	Disintegrations per minute per square centimeter
dpm/dm^2	-	Disintegrations per minute per square decimeter
dps	-	Disintegrations per second
DRD	-	Direct reading dosimeter
DU	-	Depleted uranium
EPA	-	U.S. Environmental Protection Agency
eV	-	Electronvolt
FE	-	Feces sample
FIDLER	-	Field instrument for detection of low energy radiation
FR	-	Filter ratio
FSP	-	Field Sampling Plan
ft^2	-	Square foot
γ	-	Gamma ray
GA	-	General area
GeLi	-	Germanium - Lithium
G-M	-	Geiger-Mueller
GMC-H	-	Mine Safety Appliances Company, full-facepiece, dual ..combination filter cartridges for an APR
GPD	-	Gaseous Diffusion Plang
h	-	hours
He-3	-	Helium Three (3)

HEPA	-	High efficiency particulate air
HNO_3	-	Nitric acid
HP	-	Health Physics
hr	-	Hour
HS	-	Hot spot (radiation)
HSP	-	Site-specific Health and Safety Plan
HWP	-	Hazardous Work Permit
ICRP	-	International Commission on Radiological Protection
ID	-	Identification
IDLH	-	Immediately dangerous to life or health
IDW	-	Investigation derived waste
IP	-	Ionization potential
IVC	-	Independent verification contractor
keV	-	Kiloelectronvolt
kg	-	Kilogram
LANL	-	Los Alamos National Laboratory
lpm	-	Liters Per Minute
MCA	-	Multi-channel analyzer
MDA	-	Minimum detectable activity
meV	-	Millielectronvolt
m	-	Meter
m^2	-	Squared Meters
m^3	-	Cubic meters
mCi	-	MilliCurie
MSHP	-	Manager, Vista Safety and Health Program
mil	-	1/1000 inch
ml	-	Milliliter
mm	-	Millimeter
mR	-	MilliRoentgen
mR/hr	-	MilliRoentgens per hour
mrem	-	Millirem
mrem/hr	-	Millirems per hour
MSA	-	Mine Safety Appliances Company
MSDS	-	Material Safety Data Sheet
MSHA	-	Mine Safety and Health Administration
NaI	-	Sodium iodide
NCA	-	Nuclear Criticality Analysis
NCS	-	Nuclear Criticality Safety
NCRP	-	National Council on Radiation Protection and Measurements
NEA	-	Nuclear Energy Agency
NIST	-	National Institute of Science and Technology

NIOSH	-	National Institute for Occupational Safety and Health
n. o. s.	-	Not otherwise specified
NPDES	-	National Pollutant Discharge Elimination System
NRC	-	U.S. Nuclear Regulatory Commission
NS	-	Nose swipe
NTIS	-	National Technical Information Service
NVLAP	-	National Voluntary Laboratory Accreditation Program
OHSO	-	On-Site Health and Safety Officer
ORNL	-	Oak Ridge National Laboratory
ORPO	-	On-Site Ionizing Radiation Protection Officer
OSHA	-	U.S. Occupational Safety and Health Administration
pCi	-	PicoCurie
pCi/gm	-	PicoCuries per gram
pCi/l	-	PicoCuries per liter
P.E.	-	Professional Engineer
PF	-	Protection Factor
PIC	-	Pocket Ionization Chamber
PM	-	Project Manager
PMT	-	Photomultiplier Tube
PPE	-	Personal Protective Equipment
PRP	-	Potentially Responsible Party
PRS	-	Portable ratemeter/scaler
PVC	-	Polyvinyl chloride
QA	-	Quality assurance
QC	-	Quality control
R	-	Roentgen
RA	-	Restricted (radiation) area
rad	-	Radiation absorbed dose
RAS-1	-	Kurz air sampling pump flow calibration kit
REM	-	Roentgen equivalent man
RHSC	-	Radiation Health and Safety Committee
RSO	-	VISTA Radiation Safety Officer
RWP	-	Radiation work permit
SAP	-	Sampling and Analysis Plan
SCBA	-	Self-contained breathing apparatus
SRD	-	Self-reading dosimeter
TODE	-	Total Organ Dose Equivalent
TLD	-	Thermoluminescent dosimeter
TWA	-	Time-weighted average

U^{nat}	-	Natural uranium
UR	-	Urine sample
U.S.	-	United States
VISTA	-	Vista Technologies, Inc.
VSHP	-	VISTA Safety and Health Program
VRSP	-	VISTA Radiation Safety Program
WL	-	Working Level
WP	-	Work Plan

MONITORING AND SURVEYING

1. DETERMINATION OF BACKGROUND RADIATION

1.1. Scope

This procedure is to describe the considerations for performing measurements of background radiation levels and for collecting samples of environmental media to analyze for baseline radionuclide concentrations on Vista project work sites.

1.2. Purpose

The purpose of this procedure is to describe the considerations for performing measurements of background radiation levels and for collecting samples of environmental media to analyze for baseline radionuclide concentrations.

1.3. References

- Project/Field Sampling Plan (FSP), Work Plan (WP) and Health and Safety Plan (HSP);
- NUREG/CR–1501, "Background as Residual Radioactivity Criterion for Decommissioning;"
- NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination;"
- NUREG/CR-5512, "Residual Radioactive Contamination From Decommissioning;"
- Vista Radiation Safety Program (RSP) Procedure 17.1, "Systematic and Biased Surface Soil Radiological Sampling;" and
- Vista RSP Procedure 17.3, "Water and Sediment Sampling."

1.4. Equipment

The following, or equivalent, equipment will be utilized:

Clipboard and Pen;
Ludlum Model-19 Micro R Meter (or equivalent);
Ludlum Model 3 Portable Survey Meter (or equivalent);
Sample Containers;
Survey Forms;
Site Maps and/or Diagrams;
Sampling Equipment; and
Radiation Work Permit (RWP);
Hot Spot Flag Markers
Measuring Tape
Gridmarkers

1.5.Procedures

1.5.1. Locations

Locations for measurement and sampling are selected from within a 0.5 to 10-km radius of the site.

Locations should be undisturbed by radioactivity from the candidate site or other manmade sources (e.g., fertilizers containing elevated concentrations of uranium and potassium and building materials with high natural levels of uranium and thorium).
A minimum of seven (7) to ten (10) samples or measurements, representing the four major directions (if possible) from the site should be obtained.

1.5.2. Background Measurements

Background readings should be established by taking background measurements at a remote geographic location that is not contaminated with any radioactive material. Measure the external gamma exposure at the surface and at approximately 1 meter above the ground surface using a gamma exposure meter.

If appropriate for the specific site, measure the beta/gamma dose rate at approximately 1-cm above the ground surface.

Preferable locations for interior background determinations are within on-site buildings of similar construction, but having no history of licensed operations.

1.5.3. Baseline Sampling

The quantity and location of soil, water, and sediment samples will be taken in accordance with the Field Safety Plan (FSP).

Collect soil samples as appropriate. Surface soil sampling procedures are described in Vista Procedure 17.1, "Systematic and Biased Surface Soil Radiological Sampling," and subsurface soil sampling is described in Vista Procedure 17.2, "Subsurface Soil Radiological Sampling."

Collect water samples as appropriate from surface sources upstream from the site of concern. Water sampling procedures are described in Vista Procedure 17.3, "Water and Sediment Sampling." Sediment samples and as special by customer requirements should also be collected as described in Vista Procedure 17.3 at locations where surface water is obtained.

Collect samples of other environmental media (e.g., air and vegetation) as directed by the Vista On-site Radiation Protection Officer (ORPO).

Document all samples obtained in the field sample log.

1.6. Documentation

All monthly remote background measurements should be documented on the form shown as Attachment 20, as well as all instrument information, type, serial number, conversion, and so forth.

Maps, drawings, and photographs of all sample/survey locations should be included to permit reproduction in future background measurements. A copy of the background data should be retained at the site for reference as needed. Background measurements will be made at a minimum of seven (7) to ten (10) remote locations.

Seven (7) to ten (10) independent measurements at each location will be made (except the PIC), and documented individually on the form shown as Attachment 20. Background measurements will be made at all sites where characterization or remedial action activities are scheduled. Special cases may be made for not conducting background measurements where activities are not dependent on this type of information.

2. RADIATION AND CONTAMINATION SURVEY TECHNIQUES

2.1. Scope

This procedure provides guidelines for the performance and documentation of Radiation and Contamination surveys on Vista project work sites.

2.2. Purpose

The purpose of this procedure is to specify requirements for consistent general radiological surveys and documentation of acquired data for routine, pre-operation and post-operation surveys as well as job coverage surveys. This procedure is intended to satisfy the requirements of 10 CFR 20.

2.3. References

- 10 CFR 20, "Standards for Protection Against Radiation;"
- ANSI N3.1 , "Selection, Qualifications and Training of Personnel For Nuclear Power Plants;" and
- NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination,".

2.4. Precautions and Limitations

2.4.1. Precautions

The following precautions should be observed when performing surveys:

- Personnel performing surveys in known or suspected contaminated areas should avoid unnecessary contamination of survey instruments by using plastic film coverings and exercising care. Covering the mylar window may decrease the beta and alpha efficiency; avoid covering mylar windows.

- Exercise care when performing contact measurements with the mylar window exposed to prevent damage.
- Avoid unnecessary exposure when performing surveys by using good As Low As Reasonably Achievable (ALARA) practices.
- The surveyor should be aware of:

  - The operation and limitations of the survey instrument(s) used; refer to the particular instrument's operation and calibration procedure;
  - The suspected and anticipated range of radiation and contamination levels in the area to be surveyed;
  - Activities in the area that may or will change radiological safety conditions;
  - Safety considerations and requirements in effect in the area to be surveyed; and
  - The nature of the work to be performed in the area to be surveyed if the survey is to be used for Radiation Work Permit (RWP) generation.

- Radiation surveys used as a basis for RWPs or area postings will be performed by the Vista ORPO or Health Physics Technicians and meet the requirements of American National Standards Institute (ANSI) 3.1.
- The Vista ORPO will leave an area immediately if, during the survey, the radiation detection instrument in use appears to be malfunctioning or radiological conditions in the area being surveyed change unexpectedly.
- All material such as smears or other survey materials will be treated as radioactive material until a survey is performed on the material in question.
- Sources of radiation smaller than the open window area of an ion chamber instrument may require the use of different beta correction factors. Also, the field beta correction factor and the contact beta correction factor will differ. Refer to the appropriate ion chamber operation and calibration procedure or the calibration sticker for these values.
- Contact exposure rates will be measured at a distance of less than one inch from the source of radiation.
- Thirty-centimeter (~12 inches) readings will be used as the whole body reading for posting purposes.
- Prior to entering the area or performing any survey, each radiation detection instrument will be:

  - Battery and Source Checked;
  - Checked for obvious physical damage;
  - Qualitative response-checked daily prior to use;
  - Checked to ensure the instrument is within current calibration; and
  - If either the battery or source checks fail; then an identical (or equivalent) instrument must be submitted and used.

- "If site and building drawings and other documentation are not available, or if that information is not reliable; then a Ground Penetrating Radar (GPR) system should be used to locate and/or identify underground structures.

2.4.2. Limitations

The following are surveying limitations:

- This procedure does not apply to characterization surveys, nor is it intended to alter current or future characterization survey techniques.
- For exposure rate surveys used to determine RWP requirements, job coverage, or stay times, an ion chamber instrument should be used.
- When using cloths (or masslin) to perform large area smears, results will be reported in Disintegrations Per Minute (DPM) or mrad/hr above background. Do not attempt to quantify the survey area.
- Radiation and contamination surveys may be used to support RWPs if the survey has been performed within 24 hours of RWP initiation or there is reasonable assurance that conditions have not changed.

2.5. Procedure

2.5.1. General

- Radiation and contamination surveys will be performed on an as-needed basis. The need for performing a survey is identified by the following conditions:

  (a) An Radiation Work Permit (RWP) is needed to perform an approved job;
  (b) A procedural requirement requires a survey;
  (c) A condition exists where radiological data is needed to form a decision by the Vista ORPO;
  (d) An investigation is required due to abnormal conditions or indications; or
  (e) An on-going job requires a survey to update radiological postings and/or the RWP.

- Determine the type of survey to be performed and select the proper radiation detection instrument(s) for the survey including the following:

  (a) Select an instrument capable of detecting the type of radiation to be surveyed;
  (b) Select an instrument capable of detecting the range of exposure rates or contamination levels expected;
  (c) Select an instrument calibrated to the range of expected emission energy; and
  (d) Select an instrument that has been calibrated for the type of radiation to be surveyed.

- Review and sign in on the applicable RWP for the area to be surveyed.
- When entering posted or suspected high radiation areas, or unknown areas, the ion chamber instrument range selector switch will be selected to the highest range and moved down through the lower ranges until the meter indicates on scale.

When surveying for radiation levels using an ion chamber, gamma readings will be taken with the beta window closed.

When surveying for beta radiation levels using an ion chamber, readings will be taken with the beta Window Open (OW) and then Closed Window (CW). The Beta Correction Factor (BCF) for contact beta readings is listed on the instrument calibration sticker. The beta correction factor for field beta readings (30 centimeters from source) is 1.50.

Corrected beta dose rate = (OW-CW) X CF

- Instruments used to perform radiation and contamination surveys will be operated in accordance with their operation and calibration procedure.

2.5.2. Standard Health Physics Practices Concerning Performance of Radiation Surveys

The following standard health physics practices for surveys should be observed:

- Check out necessary survey instruments and comply with operational procedures of the instrument's operation and calibration procedure.
- The instrument's operation and calibration procedure may be used to assist in determining necessary survey instruments. Instrument limitations are described in these procedures.
- General Area Beta/Gamma Radiation Surveys should consider the following:

  (a) General area surveys are normally conducted to measure only gamma radiation levels. However, when suspected, general area beta radiation levels can be measured with a Ludlum Model-9 instrument (or equivalent) using the field beta correction factor of 1.5 Document all general area beta radiation levels > 1 mrad/HR on the survey form;
  (b) For general area room surveys, hold the instrument detector at waist to chest level, utilizing the highest reading obtained for documentation of survey records and postings. Normally, general area surveys are considered as being greater than 30 cm away from relevant components and equipment; and
  (c) General area room surveys for RWPs should include accessible areas and positions or levels where personnel will be performing work.

- Survey data should be documented in accordance with section 2.6 of this procedure.

2.5.3. Contact Beta/Gamma Radiation Surveys

- Contact surveys should be taken at approximately one inch away from relevant components and equipment.

Conduct contact Beta/Gamma Radiation surveys during the following conditions:

(a) On open radioactive sources and exposed contaminated equipment; or
(b) Whenever leakage from a radioactive source is in evidence or is suspected to have occurred.

- Contact surveys should also be taken on relevant components and equipment which personnel will be likely to contact during the performance of their work.
- When conducting contact surveys on surfaces with high levels of exposed surface contamination, obtain an open window reading and a closed window reading to determine the beta contribution.

Denote all corrected Beta readings on the survey form.

True Beta Dose Rate is determined by OW reading minus CW reading times the beta correction factor of 1.5 for field beta measurements or the contact beta correction factor found on the calibration stickers for contact beta measurements.

- Document survey data in accordance with section 2.6 of this procedure

2.5.4. Standard Health Physics Practices Concerning Transferable Contamination Surveys

- The smear survey procedure follows:

(a) Wipe a cloth or paper disc smear over an area of 100 square centimeters (cm^2). 100 cm^2 is approximately a four-inch square or an 18-inch "S".
(b) Avoid cross-contaminating the smear samples by double bagging the samples individually.
(c) Count the disc smears on the appropriate counting equipment. The following guidelines should be used when counting smears:

1) The Ludlum Model-3/44-9 or equivalent should be used for counting smears > 1,000 DPM and smears taken in posted contaminated areas for beta-gamma.
2) The Ludlum Model-3/43-5 or equivalent should be used to count smears obtained from contaminated areas for α.
3) All smears taken for the purpose of determining if the item or area smeared is below the posting requirements for loose activity in accordance with Vista Procedure 18.1, "Controlled Areas," must be counted on instruments capable of detecting 20 DPM α and 1,000 DPM β-γ (Ludlum Model-2929 or equivalent).
4) Report results in units of DPM/100 cm^2.
5) Smear results >50,000 Counts Per Minute (CPM) may be reported in mrad/hr/100 cm^2.

- The Large Area Smear Survey (Wipe) procedure follows:

(a) Large area smears are used to obtain a gross indication of contamination levels in large areas or on pieces of equipment suspected to have contamination present. Large area smears may also be used to check normally clean areas or equipment for presence of contamination.

(b) Wipe over the surface to be surveyed.
(c) Count the wipe with a count rate meter equipped with a 44-9 probe or equivalent for β-γ and/or a Ludlum Model-3/43-5, or equivalent, for α.
(d) Use the highest reading obtained for reporting results. Results should be recorded in units of DPM/wipe above background.

1) If using wipes to check a clean area or piece of equipment for contamination and if there is indication of activity above background on the wipe, the area must be smeared using disc smears in accordance with the Smear Survey step of this procedure.

(e) Document results in accordance with Section 2.6 of this procedure.

2.5.5. Standard Health Physics Practices Concerning Fixed Contamination Surveys

The following is a guide for fixed contamination surveys:

- Fixed contamination survey instruments are used to obtain indications of fixed contamination levels on surface areas, pieces of equipment, or tools for characterization and/or release surveys.
- When surveying for fixed β- contamination the probe should be held within one-half inch or less from the surface being surveyed. The movement rate of the detector probe should be one probe width per second or slower.
- When surveying for fixed α contamination the probe should be held within one-quarter inch or less from the surface being surveyed. The movement rate of the detector probe should be one probe width per second or slower.
- When performing direct scan surveys of objects, surface areas, etc., static readings should be performed frequently to insure the detection of residual activity.
- When performing free release or characterization surveys, 100 % of all accessible areas should be direct frisk surveyed.
- Use the highest reading obtained for reporting results. Results should be reported in units of net CPM above background or DPM/100 cm^2.

(a) The following formula should be used for converting direct probe readings in CPM to DPM/100 cm^2:

$$DPM/100\ cm^2 = [(Gross\ CPM - Background\ CPM) \times (100)]/[(Efficiency) \times (Probe\ Area)]$$

Efficiency = Instrument Efficiency or Sensitivity (CPM/DPM)
Probe Area (cm^2)

- Document the results in accordance with Section 2.6 of this procedure.

2.6. Documentation of Surveys

- All radiation and contamination surveys will be documented on Attachments 20 through 28 including the following:

  (a) Smears counted with portable instruments will have the results recorded;
  (b) Drawings and documents will be included to clearly explain survey locations;
  (c) Survey numbers are obtained from the Radiation/Contamination Survey Log, Attachment 66;
  (d) Readings are recorded in mR/hr;
  (e) Corrected β readings will be annotated as such;
  (f) Neutron readings will be annotated as mrem/hr;
  (g) Alpha values will be annotated with the α symbol;
  (h) Beta values will be annotated with the β symbol;
  (i) Contact readings will be annotated with an asterisk;
  (j) 30 cm readings will be annotated with the value underlined;
  (k) Smear locations will be annotated with the number circled;
  (l) Large area smears will be numbered with the number inside a triangle; and
  (m) A narrative explanation of abnormal or unsafe conditions should be included on the survey.

- Smears counted with fixed instrumentation will be recorded on Attachment 22.
- Isotopic analysis results shall be attached to Attachment 21. The survey number shall be recorded on each page in accordance with Attachment 66.

3. RADIOACTIVE CONTAMINATION SURVEYS IN STRUCTURES

The following sections discuss delineation of survey areas in structures, direct surface radioactive contamination survey, and transferable surface radioactive contamination survey.

3.1. Delineation of Survey Areas in Structures

The purpose of this procedure for delineation of survey areas in structures is to describe all methods used in delineating survey areas inside structures and properly documenting the resulting survey data at Vista project work sites.

This procedure includes a description of techniques used to establish radiation survey grids and the types of radiation measurements to be performed.

The applicable references are:

- Section 3.2, "Direct Surface Radioactive Contamination Survey"; and
- Section 3.3, "Transferable Surface Radioactive Contamination Survey" of this procedure.

3.1.1. Necessary Supplies

The following, or equivalent, are necessary supplies:

- Clipboard and Pen
- Diagrams and Sketches
- Maps and/or drawings of structure.
- Grid markers and measuring tools.
- Paper or clothe swipes and envelopes.
- "Direct Surface Contamination Survey Form," shown as Attachment 21.
- "Transferable Surface Contamination Survey (Smear) Form," shown as Attachment 22.
- Ludlum Model –3 Survey Meter.
- Ludlum Model 19 Micron R Meter.
- Ludlum Model 9 Ion Chamber.
- Ludlum Model 2929 Dual Channel Scalar.
- Instruments as Required for Site Specific Activities, **Or Equivalent**
- Hot Spot Flag Markers
- Radiation Work Permit (RWP).

3.1.2. Specific Instructions

The following are specific instructions to delineate survey areas:

- Types of Radiation Measurements

  – Direct and transferable α particle contamination;
  – Direct and transferable ß particle and γ ray contamination; and
  – ß particle and γ ray dose rate (if required by the Vista ORPO);
  – Direct neutron dose rate.

- Defining Structural Surfaces

  - Review past radiological survey reports, if any, for the structure to be surveyed. Perform a pre-entry survey, if radiation levels are unknown, to determine health physics controls that will be required for personnel protection during the survey (i.e., protective clothing, air monitoring, and so forth);
  - Radiation survey areas can be defined as the first level of a building, a roof, or a single room; and
  - Divide each survey area into two sub-units.

- Floors and walls are up to a height of 2 meters and any other surfaces accessible while standing on the floor.
- Overhead surfaces are composed of ceiling surfaces and wall surfaces more than 2 meters above the floor.

- Divide both sub-units into a survey grid system measuring between one and three meters or as otherwise defined by the characterization plan. The grid system will consist of a series of mutually perpendicular lines that will be identified by painted/chalked cross marks at the intersection of the grid lines. Measurement data should be designated so as to distinguish lower wall and floor data.
- Five uniformly spaced points in each grid area should be selected. At each point, direct and transferable surface radioactive contamination measurements will be made as well as ß particle\γ ray dose rate measurements (if required by the Vista ORPO).

3.1.3. Documentation

For each survey grid block, an average will be determined (unless otherwise directed by the PM) using the five measurements for the following:

- Transferable α particle contamination (DPM/100 cm^2);
- Transferable ß particle and γ contamination (DPM/100 cm^2);
- Direct α particle contamination (DPM/100 cm^2);
- Direct ß particle and γ contamination (DPM/100 cm^2); and
- ß particle and γ ray dose rate (mR/hr, if required by the Vista ORPO)
- Neutron Dose Rate (mR/hr).

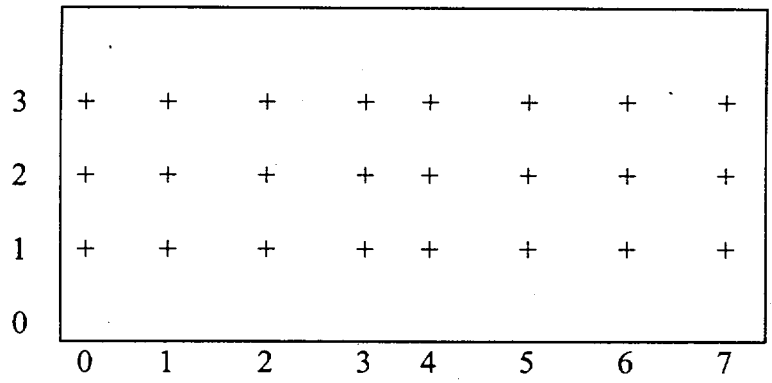
Report these averages with the data collected.

All measurements and results must be reported on the form shown as "Direct Surface Contamination Survey Form," Attachment 21, and/or the form shown as "Transferable Surface Contamination Survey (Smear) Form," Attachment 22. The forms will be completed as described in Section 1.3.2, "Direct Surface Radioactive Contamination Survey," and Section 1.3.3, "Transferable Surface Radioactive Contamination Survey" of this procedure. A pattern for direct and transferable ionizing radiation measurements in each grid block is shown below.

Typical Radiation Survey Grid for a Structure Floor

NORTH
(meters)

(PLAN (TOP) VIEW)



Pattern for Direct and Transferable Radiation Measurements in each Grid Block

NOTE: Other survey patterns may be applied when specified by the client or Regulatory agencies. Report all measurements in DPM/100 cm^2 unless otherwise directed by the Vista RSO.

3.1.4. Summary of Residual Radioactive Contamination Guidelines

- Base Dose Limits

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr.

- Soil (Land) Guidelines (Maximum Limits for Unrestricted Use)

For Radium-226 (^{226}Ra), the maximum soil concentration (pCi/g) above background is 5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g for Radium-228 (^{228}Ra) averaged over any 14-cm-thick soil layer below the surface layer.

For other radionuclides, soil guidelines must be calculated on a site-specific basis.

- Structure Guidelines (Maximum Limits for Unrestricted Use) Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products will apply to existing occupied or habitable structures on private property that are intended for unrestricted use. Structures that will be demolished or buried are excluded. The applicable generic guideline found in 40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill

Tailings," is as follows: In any occupied or habitable building, the objective of remedial action will be, and a reasonable effort will be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.

In any case, the radon decay product concentration (including background) will not exceed 0.03 WL. Remedial actions are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

- External γ Ray Radiation

The average level of γ ray radiation inside a building or habitable structure on a site to be released for unrestricted use should not exceed the background level by more than 20 μR/h.

3.2. Direct Surface Radioactive Contamination Survey

The purpose of this procedure for a direct surface radioactive contamination survey is to provide instruction on performing and recording the results of direct surface radioactive contamination surveys at Vista project work sites. This procedure describes how to perform direct surface radioactive contamination surveys and the proper calculation and reporting of the resulting survey data.

3.2.1. Necessary, or Equivalent, Supplies

- Maps and/or drawings.
- Historical Building Documents.
- "Direct Surface Contamination Survey Form," shown as Attachment 21.
- Micro-R Meter.
- Ion-Chamber.
- Survey Meter.
- Analyzer with Ludlum Model 43-68 Gas Proportional Counter, or equivalent
- Multichannel Analyzer (MCA) System
- Clipboard and Pen.
- Equipment for contamination removal (on a per case basis)

3.2.2. Direct Alpha Particle Instruments

The following is the procedure for direct alpha particle surveys:

- Determine the background count rate, and source check the α particle scintillation detector/portable scalar. Place the alpha particle scintillation detector near (on contact or just above) the surface at the selected survey point or location. Exercise care in positioning the detector near the surface when transferable radioactive contamination is present, and to prevent puncture of the aluminized window.
- Take a measurement using a predetermined counting duration. The counting duration should be at least 30 seconds. All results should be converted to counts per minute.

- Record the location and count rate on Attachment 21 and perform calculations as shown below:

  – Determine the activity per unit area (DPM/100 cm^2):

  EXAMPLE:

  Net CPM: 100
  Efficiency (percent): 15.0
  Detector Window Area (cm^2): 59
  Or detector window ratio to scale: 0.59
  To determine DPM/100 cm^2:

$$DPM/100\ cm^2 = 100/[(0.59) \times (0.15)] = 1130\ DPM/100\ cm^2$$

NOTE: Use ratio to scale equivalents for efficiency (percent) and area (cm^2) to determine DPM/100 cm^2.

- Calculate the Minimum Detectable Activity (ACTIVITY PER UNIT AREA) and standard deviation, if required by the Vista ORPO, according to Appendix A, National Council on Radiation Protection and Measurement (NCRP) No. 97, 1988, "Measurement of Radon and Radon Daughters in Air."

3.2.3. Direct Beta Particle and Gamma Ray Measurements

The following is the procedure for direct beta/gamma surveys:

- Determine background count rate, and source check G-M detector/portable scaler. Place the G-M detector on or near the surface at the selected survey point or location. The detector should be positioned within 1 centimeter of the surface being surveyed.
- Take a measurement using a predetermined counting duration. The counting duration will be at least 30 seconds. All results should be converted to counts per minute.
- Record the location and count rate on Attachment 21 and perform calculations as shown below.

  – Determine the activity per unit area (DPM/100 cm^2):

  EXAMPLE

  Net CPM: 500
  Efficiency (percent): 15.0
  Detector Window Area (cm^2): 15.5

Note: Use ratio to scale equivalents for efficiency (percent) and area (cm^2) to determine DPM/100 cm^2.

$$DPM/100\ cm^2 = 500 / [(0.15) \times (0.155)]$$

- Calculate the activity per unit area and standard deviation, if required by the Vista ORPO, according to Appendix A, NCRP No. 97, "Measurement of Radon and Radon Daughters in Air."

NOTE: The above relation is based on the assumption that most of the detector's response is due to ß particle radiation. The presence of significant γ ray radiation could result in an erroneous estimate of ß particle activity. One quick method to check this potential is to shield ß emissions with a piece of 1/4-inch thick plastic (plexiglas or equivalent). A simple comparison of count rate response, shielded versus unshielded, will provide a proportional ratio of γ ray activity versus ß particle and γ ray activity.

The following assumptions may be used.

Unshielded = ß particles + γ rays
Shielded = γ rays
Unshielded - Shielded = ß particles

This type of data can provide valuable information when dealing with radioactive contamination such as Uranium-238 (^{238}U) --> Protactinium-234 (^{234}Pa), and high energy ß particle emitters. Furthermore, in cases where γ ray emissions are predominant, this may eliminate the possibility of ß particle-emitting radionuclides as the contaminant source.

3.2.4. Additional Survey Measurements

- Obtain and record a duplicate count (D) for direct readings of approximately two in every ten measurements for α and ß particles, and γ rays. The location will be chosen by a random number generator; and
- Record any observed hot spot measurements on the same form with the direct surface measurements and identify the readings as hot spots. Sketch hot spot locations on a grid drawing of the area being surveyed.

3.3. Transferable Surface Radioactive Contamination Survey

The purpose of this procedure for a transferable surface radioactive contamination survey is to provide instruction for measuring and documenting the results of transferable surface radioactive contamination surveys at Vista project work sites. This procedure describes the method for performing transferable surface radioactive contamination surveys, calculations of activity levels, and reporting methods.

3.3.1. Necessary Supplies

- Maps and/or drawings.

- Historical Documents
- "Transferable Surface Contamination Survey (Smear) Form," shown as Attachment 22.
- Scintillation α particle counter.
- Portable rate meter/scalar.
- ß particle/γ ray "pancake" G-M detector (7 mg/cm^2 mylar shielded) with Gas Proportional Counter.
- Paper or cloth smears and envelopes (smear diameter = 40 mm)
- Clipboard and Pen
- Measuring Tools
- Gridmarkers
- Hot Spot Flag Markers
- RWP.

3.3.2. Transferable Radioactivity Measurements

Transferable surface radioactive contamination surveys will be taken on floors, walls, equipment, and on representative items in the survey area. Transferable radioactive contamination will be measured using a paper or cloth smear according to the following procedure:

- Use approximately 40 millimeter (mm) (1.57 inch) diameter cloth or paper smears.
- Swipe a 10- by 10-cm (3.9-inch by 3.9-inch) area as required.
- Each smear should represent an area of 100 cm^2 at the survey location.
- Place the smear in an envelope labeled with the survey location, survey date, and the initials of the Vista field technical staff performing the survey.
- Count the smear with appropriate counting equipment to determine transferable radioactive contamination.
- Record smear sample location and count data from the following instructions found on the form shown as Attachment 22.
- ß Particle/γ Ray Counting procedure

  - Determine the background count rate, and source check the G-M detector/portable scalar setup using SH-4A sample holder.
  - Using tweezers, remove the smear from the envelope, and position the smear on a sample tray drawer of the SH-4A sample holder.
  - Close the sample tray drawer and count the sample for 1 minute.
  - Remove the smear from the sample tray drawer (using tweezers), and place it back into the envelope from which it was removed. The Vista ORPO will determine when the smears can be discarded.
  - Record the net count rate on the form shown as Attachment 22.

Net Count Rate (CPM) = Gross Sample CPM - Background CPM

Calculate DPM/100 cm^2 for sample as follows:

Net count (CPM) ÷ Efficiency of the β particle detector = DPM/100 cm^{2S}

Calculate the activity per unit area and standard deviation, if required by the Vista ORPO, according to Appendix A, NCRP No. 97, "Measurement of Radon and Radon Daughters in Air."

- α Particle Counting

  - Determine the background count rate and perform a quantitative source check of the Ludlum Model 2929, or equivalent, per Procedure 12.
  - Using tweezers, remove the smear from the envelope, and position the smear on a sample tray drawer of the SH-4A sample holder.
  - Close the sample tray drawer and count the sample for 1 minute.
  - Remove the smear from the sample tray drawer (using tweezers), and place it back into the envelope from which is it was removed. The Vista ORPO will determine when the smears can be discarded.
  - Record the net count rate on the form shown as Attachment 22.

Net Count Rate (CPM) = Gross sample CPM - Background CPM

Calculate DPM/100 cm^2 for the sample as follows:

Net count rate (CPM) $\div$ Efficiency of the α particle counter = DPM/100 cm^2

- Calculate the activity per unit area and standard deviation, if required by the Vista ORPO, according to Appendix A, NCRP No. 97, "Measurement of Radon and Radon Daughters in Air."

3.3.3. Quality Control

(D)s will be performed on 20 percent of all samples and recorded on the form shown as Attachment 22.

3.3.4. Hot Spot Survey

Each monitoring grid block will have a location, identified by the direct ß particle and γ ray scan survey, possessing the highest count rate. Such a location is called a Hot Spot (HS). If the count rate exceeds the direct measurements previously performed, a smear will be collected at the location.

4. RADIOACTIVE CONTAMINATION SURVEYS IN OPEN LAND

The following sections discuss delineation of survey areas in open land, near-surface gamma ray radiation surveys, gamma ray exposure rate surveys at one meter in open and enclosed areas, walkover gamma ray scans, subsurface gamma ray radiation logging, and surface gamma ray radiation surveys.

4.1. Delineation of Survey Areas in Open Land

The purpose of this procedure for delineation of survey areas in open land is to describe the methods used to delineate survey areas and to perform post remedial action measurements in excavation or open land areas at Vista project work sites. This procedure includes a description of the appropriate methods used to establish a post remedial action survey and specific measurements to be performed.

The applicable references are:

- Vista RSP Procedure 17.1, "Systematic and Bias Surface Soil Radiological Sampling;"
- Vista RSP Procedure 17.2, "Subsurface Soil Radiological Sampling;" and
- Attachment 24, "Walkover Gamma Ray Scan Data Sheet (Large Area) Form."

The following sections delineate necessary supplies, specific instructions, and documentation.

4.1.1. Necessary Supplies

- Portable rate meter/scalar (Ion Chamber).
- γ ray scintillation detector or equivalent
- Cone shield apparatus.
- Maps, drawings
- Clipboard and Pen
- MCA System
- Measuring Tools
- Gridmarkers
- Hot Spot Flag Markers
- RWP

4.1.2. Specific Instructions

The following types of measurements should be performed:

- A systematic grid will be established prior to any radiological surveys or sampling. The grid may be in meters or feet as directed by the Project Manager (PM).
- Once the survey grid has been established, initial surveys may begin. A walkover γ ray survey should be conducted on sites where γ ray-emitting contamination is present. The survey should be conducted with a Micro-R Meter, or equivalent, at or near ground proximity. Results of the survey should be documented with emphasis placed on the documentation of HSs.
- Data plotted in relation to the grid will include all characteristic information such as buildings, ditches, mounds, or any other object that may assist in the evaluation of the survey.
- If soil radioactive contamination is of the nature that γ ray surveys are not practical, systematic soil sampling should be conducted over the property (see Vistas RSP

Procedure 17.1, "Systematic and Bias Surface Soil Radiological Sampling," and 17.2, "Subsurface Soil Radiological Sampling."

- In areas where γ ray radiation levels could be construed as marginal by the Independent Verification Contractor (IVC), additional sampling should be implemented for averaging purposes. Additionally, in areas where elevated γ ray readings are noted, individual hot spot sampling should be conducted to better define hot spot/maximum soil activities, pCi/g.
- Pocket Ionization Chamber (PIC) measurements should be conducted in conjunction with cone shield apparatus measurements. The measurements may be conducted with a cross-calibrated SPA-3, providing such cross calibration has been conducted within the area being surveyed or an area where radioactive contamination type(s) are the same.

4.1.3. Documentation

All measurements, grid locations, and identifications will be recorded on Attachment 24, "Walkover Gamma Ray Scan Data Sheet (Large Area) Form". Documentation per Sections 17.1.4 and 17.2.9 may also be required.

4.1.4. Near-Surface Gamma Ray Radiation Survey

The purpose of this procedure for a near surface γ ray radiation survey is to describe the method for near surface γ ray measurements with the cone shield apparatus in open land areas at Vista project work sites. This procedure includes a description of the method used to perform near surface γ ray measurements. It also includes a technique for making estimates of radionuclide concentrations in soil.

The applicable references are:

- Section 1.1, "Determination of Background Radiation" of this procedure;
- Attachment 20, "Remote Background Location Data Form;" and
- Attachment 25, "Near Surface Gamma Ray Radiation Survey Form."

4.1.5. Necessary Supplies

- Cone shield apparatus.
- Portable rate meter/scalar (Ion-Chamber).
- γ ray scintillation detector.
- Survey maps and/or drawings.
- "Near Surface Gamma Ray Radiation Survey Form," shown as Attachment 25.
- Clipboard and Pen
- Measuring Tools
- Gridmarkers
- Hot Spot Flag Markers
- RWP

- Grid markers and measuring tools.
- Clipboard/pen.

The applicable reference is Section 1, "Determination of Background Radiation" of this procedure.

4.1.6 Specific Instructions

- Defining Areas:

  - The area to be surveyed should be divided into grid sections as defined in the site-specific work plan. Typical grid surveys will require 25 survey points within a 100-square-meter area for unaffected areas for survey and 100% survey for affected areas as needed.
  - The grid system should be identified by north-south and east-west coordinates that would enable a future duplication of measurements and delineation of contaminated areas.
  - Background levels of radiation should be determined monthly in a location remote from the site as specified in Section 1, "Determination of Background Radiation" of this procedure , and document the results on the form shown as "Remote Background Location Data Form," Attachment 20.
  - The γ ray scintillation detector/portable rate meter-scalar should be source checked and the results recorded. On-site background data will be used when source checking instruments only.
  - The γ ray scintillation detector should be placed in the cone shield apparatus mounted on a wheeled dolly. The portable rate meter/scalar should be secured on the cone shield apparatus. This setup ensures the detector-to-soil distance is maintained at 30 cm.
  - Near surface γ ray measurements should be made at the intersection of grid lines.
  - A 0.5 minute timed count should be taken at each grid point location.
  - The measurement should be recorded on the form shown as "Near Surface Gamma Ray Radiation Survey Form," Attachment 25.
  - Conversion factors (CPM/pCi/g) are established by several methods. A conversion factor for a near-surface γ ray (cone shield apparatus) survey should consist of making several measurements and acquiring soil samples at these locations. The measurements should be over a full range of γ ray intensities. Note, however, other factors may influence these types of conversion factors such as radioactive contamination type, soil density, soil moisture, location of contamination from the ground surface, and so forth.

- Quality Control

  - A Duplicate (D) should be performed for one in every twenty (20) readings.
  - The location will be chosen at random by the Vista ORPO.
  - (D)s will be taken after all grid measurements have been completed.
  - The (D) will be recorded on the same survey form with the original measurement.

4.1.7. Documentation

All measurements, grid locations, and identifications will be recorded on Attachment 25, "Near Surface Gamma Ray Radiation Survey Form." Remote background data will be recorded on Attachment 20, "Remote Background Location Data Form".

4.2. Gamma Ray Exposure Rate Surveys at One Meter in Open and Enclosed Areas

The purpose of this procedure for γ ray exposure rate surveys at one meter in open and enclosed areas is to describe the methodology for measuring γ ray exposure rates in pre- and post-remedial action areas, inclusive of open land areas and structures at Vista project work sites. This procedure includes a description of the techniques and instrumentation used during such exposure rate determinations. All measurements are to be made in the prescribed manner at 1 meter above the ground or floor where applicable.

The applicable references are:

- Attachment 26, "Gamma Ray Exposure Rate Survey Form."

4.2.1. Necessary Supplies

- Maps and drawings.
- Historical Documents
- Grid markers and measuring tape.
- "Gamma Ray Exposure Rate Survey Form," shown as Attachment 26.
- Portable rate meter/scalar (Ion-Chamber).
- γ ray scintillation detector or equivalent
- Hot Spot Flag Markers
- RWP
- Clipboard and Pen

4.2.2. Specific Instructions

- Exterior Surveys

  - The area to be surveyed must be graded prior to any measurements. The established grid will be determined by the Vista ORPO.
  - The operational status of the PIC and field instrumentation must be verified. Note, the PIC will require a 24-hour charge prior to field use. All instruments should be response and background checked. The PIC background should be compared to the field instrument used and documented.
  - The number of survey locations required to adequately survey the entire area should be pre-determined. This is a judgment call, and should be discussed with the Vista ORPO. A determination should be made if the use of the PIC exclusively is practical.

- From walkover survey data, determine the range in microRoentgen per hour (μR/hr) for cross calibration of the specific detector. Use the Ludlum Model 19 Micro-R Meter or equivalent for exposure rate surveys less than 500 μR/hr. For greater than 500 μR/hr, use the Hewlett-Packard-270 or equivalent. At 15 locations, make PIC measurements using the Ludlum Model 19 Micro-R Meter, or equivalent, at one meter. Make sure that measurements encompass the entire range for exposure rates in the survey area.
- The Ludlum Model 19 Micro-R Meter, or equivalent, count rate should be related to the PIC exposure rate using a line fitting algorithm.
- Once instrument correlations have been established, all remaining γ ray exposure rates may be determined using the appropriate detector. All exposure rate determinations conducted with the Micro-R Meter, will be determined over a 5-minute preset count time. All measurements will also be conducted at 1 meter above the ground. Exposure rate surveys with the PIC will be conducted for a minimum of two integrations and at 1 meter above the ground.
- Timing is essential when making exposure rate determinations with the PIC. Actual start time to the second should be documented for time integrated exposure determinations. Upon completion of the survey, the Vista field technical staff should wait for an actual integration and document to the second. The following formula should be used to calculate the exposure rate with the time-integrated data.

Integrations /Survey Time (seconds) x 360 seconds/hour = μR/hr

- Interior Surveys:

  - During some characterization or remedial action activities, exposure rate surveys may be required in buildings or structures. The method for conducting these surveys is the same as exterior surveys except that cross calibrations of the Ludlum Model 19 Micro-R Meter, or equivalent, with the PIC may not be practical in the structure. In the event cross calibration in interior areas is not possible, cross calibrations may be conducted prior to entry into interior areas where radioactive contamination types are the same.
  - Prior to survey measurements, operational checks should be conducted on all instrumentation. If required, cross calibrations of the SPA-3 or Hewlett-Packard-270, or equivalent, should be conducted. The Vista PM will determine the survey requirements for the interior survey.
  - All areas within the structure should be surveyed to adequately determine exposure rates. All measurements should be taken at 1 meter above the floor surface or as directed by the Vista ORPO.
  - All survey data should be documented on the form shown as Attachment 26.

- Quality Control:

- A (D) should be taken for one in every 20 measurements obtained with each detector.
- The locations for (D)s must be selected at random, wherever the location.
- (D)s must be documented on the form shown as Attachment 26, and identified as (D).

- Other Considerations

  - The instruments used must be capable of detecting the γ ray energies present. Serious errors will occur if a Reuter-Stokes PIC is used to measure the exposure rates from low-energy γ ray emitter's such as Americium-241 (^{241}Am) or Depleted Uranium (DU).
  - Discordant data observations (outliers) are fairly common when attempts to cross correlate detectors are made in the field. Consequently, exposure rates measured with a Hewlett-Packard-270 energy compensated G-M or Ludlum Model 19 Micro-R γ ray scintillation detector should be regarded as rough estimates.

4.2.3. Documentation

All measurements and identifications will be recorded on Attachment 26, "Gamma Ray Exposure Rate Survey Form."

4.3. Walkover Gamma Ray Scan

The purpose of this procedure , "Walkover γ -Ray Scan", is to describe the methodology used in field walkover γ ray surveys to identify localized or gross radioactive contamination potentials for characterization or remedial action projects at Vista project work sites. This procedure includes a description of the techniques and instruments used to assess areas where radioactive contamination may exist. This procedure also includes the documentation requirements of walkover γ ray scanning.

The applicable references are:

- Section 1 of this procedure, "Determination of Background Radiation"; and
- Section 4.1.4, "Near-Surface Gamma Ray Radiation Survey" of this procedure, and
- Vista's RSP Procedure 17.1, "Systematic and Bias Surface Soil Radiological Sampling."

4.3.1. Necessary Supplies

- Portable rate meter/scalar.
- Historical Documentation
- γ ray detector (Low range 2" x 2" Sodium iodide (NaI) detector, High range, energy compensated G-M detector).or equivalent
- Headphones, if applicable.

- Vista's RSP Procedure 17, Section 1, "Systematic and Bias Surface Soil Radiological Sampling."

4.3.1 Necessary Supplies

- Portable rate meter/scalar.
- Historical Documentation
- γ ray detector (Low range 2" x 2" Sodium iodide (NaI) detector, High range, energy compensated G-M detector).or equivalent
- Headphones, if applicable.
- "Walkover Gamma Ray Scan Data Sheet Form," Attachment 23.

4.3.2 Procedure

The procedure for walkover gamma ray scans follows:

(a) Initial measurements will be conducted prior to any site grid work discussed in Section 2, "Radiation and Contamination Survey Techniques," or detailed walkover surveys discussed in Section 4.3, "Walkover Gamma Ray Scan" of this procedure, to establish maximum exposure rates. Floor cracks, fissures, cold joints, drains, and other areas of interest must be documented on the form shown as Attachment 23. These areas provide a migratory pathway for radionuclides; therefore, thorough surveys of such areas of interest must be performed along with the appropriate documentation of these surveys. Once this has been completed, systematic walkover γ scans may begin.
(b) Systematic surveys of available information should be conducted.
(c) The appropriate instrument to be used for the survey must be determined. If less than 500 μR/hr, use the 2-inch x 2-inch γ ray scintillation detector; if greater than 500 μR/hr, use an energy-compensated G-M detector.
(d) Background determination will be performed monthly at a remote location from the site as per the requirements in Section 1, "Determination of Background Radiation" of this procedure. Remote background data will be documented on "Remote Background Location Data Form," Attachment 20.
(e) All instrumentation should be checked for response. On-site background data will be used when response checking instruments only. All instrument information including background data should be documented on the form shown as "Walkover Gamma Ray Scan Data Sheet Form," Attachment 23. Audio response should be verified by checking the instruments that will be used with the headphone. The check should include placement of a γ ray source near the detector to confirm increased audio response.
(f) Begin the survey after all the above steps have been completed. The detector should be held as close to the ground as possible without touching rocks or hard objects (do not drag detector on ground).
(g) The area will be surveyed in a systematic manner using a survey pattern covering the entire area.

(h) Using the audio response of the instrument, locate areas above background. Periodically observe the meter to obtain an estimate of the average levels measured per grid block.
(i) Traverse through the graded area from one end to the other as many times as necessary until the entire area has been scanned. Record all data from the survey on the form shown as "Walkover Gamma Ray Scan Data Sheet (Large Area) Form," Attachment 24, or a blank grid map as provided by the Vista PM.
(j) For pre-remedial action surveys, the use of pin flags or paint may be used to mark boundaries or areas of radioactive contamination. Such boundaries or contaminated areas should be documented on data provided from the survey.
(k) For areas with elevated readings noted during post-remedial action or post-characterization surveys, further investigation by the collection of bias soil samples may be required. Refer to Vista's Procedure 17, "Soil, Water and Sediment Sampling Techniques." Additionally, the use of the cone shield apparatus survey to better define localized areas should be considered as discussed in Section 3, "Radioactive Contamination Surveys in Structures" of this procedure.

4.3.3 Documentation

Survey data should be documented on "Gamma Ray Exposure Rate Survey Form," shown as Attachment 26.

4.3.4 Subsurface Gamma Ray Radiation Logging

The purpose of this procedure for subsurface γ ray radiation logging is to describe the methods used to define subsurface radioactive contamination over land areas at Vista project work sites. This procedure provides directions as to how subsurface γ ray logging should be conducted to determine subsurface radioactive contamination parameters. This subsurface γ ray profile may be used to determine factors such as radioactive contamination depth, type, sampling location, and quantity.

4.3.5 Necessary Supplies

- Portable rate meter/scalar (Ion Chamber).
- Lead-shielded γ ray scintillation detector.
- Unshielded γ ray scintillation detector.
- Canberra-10 Multi Channel Analyzer (MSHPA) (if required).
- Measuring tape, forms
- Tripod support for Down Hole Probe (optional).
- Historical Documentation.
- Piping and Instrument Diagrams (P&ID)

4.3.6 Specific Instructions

The following is the subsurface gamma ray radiation logging procedure:

- Prior to subsurface measurements, the Eberline BHP and cable should be marked in depth increments (usually feet), starting from the NaI crystal as zero.
- Once the above has been completed, subsurface measurements may begin. The Vista field technical staff may decide if a polyvinyl chloride (PVC) pipe is required. This consideration will include such factors as water, hole stability, etc. Begin subsurface measurements starting from the top of the hole and continue by increments to the bottom of the hole as prescribed by the site plan or the PM.
- Document measurements after each increment on the form shown as Attachment 27. For Quality Control (QC), acquire (D)s from every fifth bore hole location. Documentation on the form shown as Attachment 27 will include all pertinent information about the bore hole.

4.4. Walkover Neutron Emission Scan

Same as Walkover Gamma Scan but use neutron detection instrumentation.

4.5. Surface Gamma Ray Radiation Survey

The purpose of this procedure for a surface γ ray radiation survey is to describe the methodology for surface γ ray measurements using the Field Instrument for the Detection of Low Energy Radiation (FIDLER) probe in open land areas to find hot spots due to low energy γ emitters at Vista project work sites.

This procedure includes a description of the methods used to perform surface γ ray measurements and the proper documentation of the resulting survey data. This Section supplements 4.3, "Walkover Gamma Ray Scan" of this procedure, to include γ ray sources of low energy.

4.5.1. Necessary, or Equivalent Supplies

- FIDLER Probe.
- Portable rate meter/scalar (Ion Chamber).
- Maps and/or drawings.
- "Near Surface Gamma Ray Radiation Survey Form," shown as Attachment 25.
- ^{241}Am Check Source > 300,000 DPM.
- Clipboard and Pen.
- Gridmarkers
- Hot Spot Flag Markers
- Measuring Tape

4.5.2. Specific Instructions

The following procedure is for surface gamma ray surveys:

- Defining Areas

- Divide the area to be surveyed into grid sections described by mutually perpendicular lines spaced 3 meters by 3 meters apart (or as otherwise defined by the project's work plan).
- Identify grid points by a north-south and east-west coordinate system that will enable a future duplication of measurements and delineation of contaminated areas.
- Determine background count rate, and source check the FIDLER probe/portable rate meter-scalar as per instructions described below.
- Assure that a FIDLER probe is secured in a protective housing.
- Conduct surface scans using the same method as described in Section 1.4.3, "Walkover Gamma Ray Scan" of this procedure.
- Make surface γ ray measurements at the intersection of grid lines.
- Remove gravel or any sharp obstruction from the surface before placing the FIDLER on the ground (for protection of the thin window), using care not to disturb the soil.
- Place the FIDLER probe housing on the surface at a grid intersection. Perform a γ ray measurement at this grid point with a count time of at least one-half minute.
- Record the reading on the form shown as Attachment 25, along with the grid coordinate.

- Quality Control

  - Perform a (D) for one in every 5 measurements.
  - The (D) will be performed after the completion of all measurements in a specific area (i.e., open yard of a vicinity property).
  - The (D) will be recorded on the same form with the original measurement and identified as a (D).

5. BETA PARTICLE AND GAMMA RAY DOSE RATE SURVEY

The purpose of this procedure for a ß particle and γ ray dose rate survey is to describe the methods for conducting direct ß and γ ray exposure rate surveys with various detectors at Vista project work sites. This procedure describes techniques for measuring proportional ß particle and γ ray radiation from surface contaminated areas. Included also are documentation and data interpretation instructions.

The following sections delineate the necessary supplies and specific instructions.

5.1. Necessary Supplies

- Portable rate meter/scalar (Ion Chamber).
- Pancake-geometry G-M Detector (Analyzer with Gas proportional counter or equivalent).
- Ion chamber thin window detector (Ion Chamber) for high range surveys.
- "Beta Particle and Gamma Ray Dose Rate Survey Form," shown as Attachment 28.

- Measuring tape.
- Maps and Diagrams
- Clipboard and Pen
- Hot Spot Flag Markers
- Gridmarkers

5.2. Specific Instructions

The following specific instructions are for beta and gamma dose rate surveys:

- Conduct investigations of the site's previous history to try to establish the types of radioactive contamination present. This may assist in determining how and where the survey should be conducted, specifically the type of instruments required.
- ß particle and γ ray dose rate surveys to be conducted in areas of radioactive contamination should be made at locations determined by the characterization plan. The surveys may be systematic or bias dependent upon parameters/requirements established in the site-specific instruction guide.
- Response and background check all instrumentation. Document all instrument information, background CPM, and instrument conversions on the form shown as Attachment 28.
- Conduct a brief walkover γ ray and cursory ß particle survey to determine peak exposure potentials prior to long-term occupation in contaminated areas.
- After completion of all the above, a detailed ß particle and γ ray exposure rate survey may begin. Place the appropriate detector (Ion Chamber with the ß particle window open or Analyzer with a Gas Proportional Counter or equivalent) on contact with the surface to be surveyed. Determine CPM ß particle plus γ rays at the survey point(s). Document the reading on the form shown as Attachment 28 for CPM ß particles plus γ rays. For γ rays only, place a piece of 1/4-inch plastic under the Analyzer with a Gas Proportional Counter or close the ß particle window shield on the Ion Chamber and determine the CPM response at the same survey location. Document this measurement CPM on the form shown as Attachment 28 in the block "gamma, CPM."
- Calculate the ß particle and γ ray proportional exposure rates as below:

  ß particle mR/hr = CPM ß particles + CPM γ rays - CPM γ ray/conversionary mR/hr = CPM γ rays/conversion

- Subtract background count rates from all measurements prior to determination of exposure rates on the form shown as Attachment 28.
- QC measurements should be conducted at the twentieth (20) survey location by a (D), and should be indicated on the form by the letter (D).

6. RELEASE SURVEYS

6.1. Scope

This procedure covers survey measurement in all affected areas. Activity includes marking survey points within established grid blocks, operation of radiation survey instruments, collection of smears and other samples, recording data and completing survey forms.

6.2. Purpose

This procedure provides instructions for taking radiation measurements and recording data in conduct of the termination survey of facilities and is designed to assure consistency and accuracy in the performance of measurements and documentation of the survey results.

6.3. References

- Project/WP, FSP and HSP;
- NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination";
- NUREG/CR-5512, "Residual Radioactive Contamination From Decommissioning";
- NUREG/CR-2082, "Monitoring for Compliance with Decommissioning Termination Survey Criteria"; and
- NRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors,"

6.4. Prerequisites and Precautions

6.4.1. Prerequisites

- Grid block markers must be in place prior to taking radiation measurements.
- Each individual performing measurements shall be familiar with the operation of all instruments that he/she uses.

6.4.2. Precautions

- Observe the two-man rule when entering confined spaces such as attics or tanks.
- When working on ladders or platforms, ensure that they are properly secured.
- Do not attempt to take measurements or smears inside energized electrical panels.

6.5. Procedures

The following procedures should be used for release surveys:

- A survey file folder is prepared for each survey unit. A new ready-for-survey folder will contain a survey control form (Attachment 67). Part one of the form identifies the area to be surveyed by zone, unit and map number.

- Upon receipt of a survey folder, the survey technician reviews the survey instruction maps and/or other appropriate attachments and identifies the grid blocks to be surveyed.
- Prior to starting the survey, the technician will resolve any questions with the Vista ORPO.
- Assemble instruments, measurement data sheets and smear envelopes.
- Complete part two of the Survey Control form, Attachment 67.
- Inspect and perform function checks on instrumentation to be used each day at the beginning of each work shift and after lunch break. Record results in the survey instrument check log book.
- Locate the first grid block to be surveyed. Confirm that it is correctly numbered by referring to the map.
- In general, three types of blocks will be encountered:

  (a) Regular smooth surface blocks with no features,
  (b) Smooth surface with penetrations or attachments which cover a small portion of the block area, and
  (c) Blocks which contain hideouts or other structures such as trenches, junction boxes, cabinets, vent ducts, and exhaust ducts.

- Measurements within Flat Surface Grid Blocks

  (a) Locate and mark points "a-e" on the grid to be surveyed with a felt tip marker. Point "a" coincides with the grid marker sticker. Use the appropriate sized template for the size of the block being surveyed. In some instances, such as at corners, there will be less than a full grid block area. The template will have to be shifted accordingly.
  (b) At one (1) meter above point "a", measure the exposure rate with a Micro-R meter or equivalent. Record the result. If the measurement cannot be taken directly above point "a" due to an obstruction, take reading as close to directly above point "a" as possible and note the fact in the remarks block.
  (c) Scan the entire block at 1 cm above surface with a G-M Pancake probe to find any maximum reading. If a maximum is found, label this location "f". Mark this point on the data sheet and on the grid block surface.
  (d) Take a 100 cm^2 smear centered at point "f". If no maximum is found, take a smear at point "a". Record the grid block number and point where it was taken on the smear holder tab. Record on the data form the smear number next to the survey point Identification (ID) on the form.
  (e) Record beta-gamma count rate measurements with the G-M probe held at 1 cm above the surface at points "a-e" (and "f" if a maximum point was found).
  (f) At points "a-e" (and "f" if applicable) measure the gamma exposure rate with a Micro-R meter at a distance of 1 cm from surface. Record the results.
  (g) Monitor points "a-e" (and "f" if applicable) for alpha contamination with an alpha survey meter. Record the results.

(h) Review the measurements and all data against the instructions for the block. Correct any deficiencies or incomplete measurements and data. Move to the next block to be surveyed.

- Measurements Within Grid Blocks Containing Penetrations, Attachments or Equipment Which Comprise Less Than One-third of the Surface Area of a complete grid.

(a) Identify the penetration(s) or attachments by sketching them and noting them on the grid layout portion of the data form. Label them "g", "h", etc. If there are not enough data rows in the data block for the measurements in a grid block, continue with the next data block. Note in the remarks section that data is continued in the next data block. Identify the next data block with the grid block ID and indicate that it is continued.
(b) Perform steps (a) through (h), i.e., the standard measurements for a flat grid block.
(c) Scan the surface of each penetration or attachment with a G-M probe. Record the highest count rate, "a" in the data row for the appropriate point "f". Mark the location of point "f" on the grid block layout.
(d) Smear the surface of each penetration or attachment and document the smear as described in section © of the Measurement within Flat Surface Grid Blocks. If an area of 100 cm^2 cannot be smeared, estimate the area smeared (in cm^2) and record in the remarks section.
(e) Review the measurements and all data against the instructions for the block. Correct any deficiencies or incomplete measurements and data. Move to the next block to be surveyed.

- Measurements Within Blocks Dominated by Hideouts or Structures (Covering More Than One Third of the Surface Area of a Complete Grid)

(a) Sketch the structure or equipment item in the grid layout area of the data form. Mark locations of measurements using "a,b,c,d,e,g,h....etc.", reserving "f" for a maximum point. These points should include both exterior and accessible interior surfaces. Care should be taken to include interiors of hoods, cabinets, walls and floors beneath cabinets. Measurements should be made on the bottom of trench covers.
(b) Perform scan of surfaces as described in section (b) of the Measurement within Flat Surface Grid Blocks to locate a maximum point.
(c) Collect a smear at maximum point. If no maximum point was identified, collect a smear at a "representative" location. Identify the location.
(d) In grid blocks containing them, at least one smear shall be taken from the interior of each penetration, including air handling system vent openings, fan motor blades, filter housings, sewers, and other potential pathways.
(e) Scale or scrapings may be taken from the interior of drains and sewer pipes and any other surfaces containing deposits which appear to cause elevated G-M Pancake readings. Label each sample with the grid block number and a location ("a,....h", etc).

(f) Mark the data form in the remarks section to indicate that samples were taken. Samplings will be handled on a case-by-case basis as discussed with the Vista ORPO.
(g) Take and record measurement one cm from the marked points with a Micro-R meter.
(h) Take and record measurements one cm from the marked points with a G-M probe.
(i) Perform an exposure rate measurement with a Micro-R meter held at the center of the grid block at a distance of one meter from the surface at that location. Record the result.
(j) Monitor the marked points for alpha contamination with an alpha probe and count rate meter. Record the results.

- Review the measurements and all data against the instructions for the block. Correct any deficiencies or incomplete measurements and data. Move to the next block to be surveyed.
- When the survey of the last grid block in the survey unit is complete, review all grid blocks to ensure that all measurements are complete and that the data is properly recorded.

7. RADIOACTIVE WIPE TEST PROCEDURE

7.1. Scope

This section describes the procedures used to perform a wipe test on radioactive devices. The wipe test is conducted on devices containing ^{3}H (tritium), ^{63}Ni, and ^{241}Am. The wipe test is intended to verify that devices containing radioactive material do not pose a threat to the environment or to an individual's health.

7.2. References

- ANSI N42.9, "Standard Test Procedures for Photomultipliers for Scintillation Counting and Glossary for Scintillation Counting Field;"
- ANSI N42.15-, "Performance Verification of Liquid Scintillation Counting System;" and
- ANSI N42.16, "Specifications for Sealed Radioactive Check Sources Used in Liquid Scintillation Counters."

7.3. Procedure

- When conducting wipe testing for ^{3}H and ^{63}Ni, the suitable filter for Liquid Scintillation (LS) is a cellulose nitrate filter that dissolves or becomes transparent when mixed with the LS fluid. Use only one type of filter and ensure that the LS counter is calibrated using the same type of filter for background as is used to take all the nickel and tritium wipes. Dampen the filter (with distilled water) prior to wiping the device. The suitable filter paper for ^{241}Am is a pressure-sensitive smear.

- Using moderate finger pressure, wipe the radioactive surface (not to exceed a 4 inch by 4 inch square) of the device with filter paper.
- Place wiped filter papers for ^{3}H and ^{63}Ni items in scintillation counter vials with 1 ml of distilled water. For ^{241}Am wipes place each filter into a sealable plastic bag. Assure the bags or vials are identified and traceable to the item tested.
- Prepare the wipe for analysis according to the filter used. These analysis procedures shall be operated in accordance with the manufacturer's recommendations.

ATTACHMENTS

Attachment 20

REMOTE BACKGROUND LOCATION DATA FORM

Site Name: _____ Site Location: _____ Date: _____

Contract Task Order No.: _____

Technicians: _____ Background Location No.: _____

Description of Location: _____

Battery Check _____volts Source Check_____

INSTRUMENT NUMBERS:

1)	Scaler _____	SN _____	Detector _____	SN _____
2)	Scaler _____	SN _____	Detector _____	SN _____
3)	Scaler _____	SN _____	Detecror _____	SN _____
4)	Scaler _____	SN _____	Detector _____	SN _____
5)	Ratemeter _____	SN _____	Detecror _____	SN _____
6)	Ratemeter _____	SN _____	Detector _____	SN _____

MEASUREMENTS:

All measurements made at _____ meters above the ground.

No.	cpm (1)	cpm (2)	cpm (3)	cpm (4)	cpm (5)	cpm (6)	(7 μR/hr)

Remarks: _____

_____

_____

_____

Attachment 21

DIRECT SURFACE CONTAMINATION SURVEY FORM

Date: _____ Area Surveyed: _____

Surveyor's Name: _____ Surveyor No. _____

ALPHA SURVEY INSTRUMENT

Scaler Model: _____
Serial Number: _____
Probe Model: _____
Serial Number: _____
Calibration Date: _____
Efficiency: _____%
Background: _____cpm
MDA: _____dpm/100cm^2
Battery Check _____volts

BETA-GAMMA SURVEY INSTRUMENT

Scaler Model: _____
Serial Number: _____
Probe Model: _____
Serial Number: _____
Calibration Date: _____
Efficiency: _____%
Background: _____cpm
MDA: _____dpm/100cm^2
Source Check_____

LOCATION/ITEM	ALPHA		BETA-GAMMA	
	Net cpm	dpm/100cm^2	Net cpm	dpm/100cm^2

Attachment 22

TRANSFERABLE SURFACE CONTAMINATION SURVEY (Smear) FORM

Date: _____ Area Surveyed: _____

Surveyor's Name: _____ Surveyor No. _____

ALPHA SURVEY INSTRUMENT

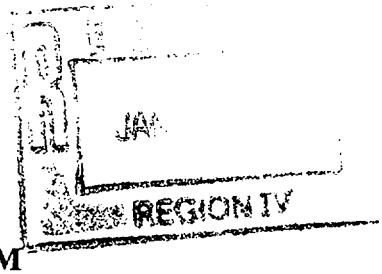
Scaler Model: _____
Serial Number: _____
Probe Model: _____
Serial Number: _____
Calibration Date: _____
Efficiency: _____%
Background: _____cpm
MDA: _____dpm/100cm^2
Battery Check _____volts

BETA-GAMMA SURVEY INSTRUMENT

Scaler Model: _____
Serial Number: _____
Probe Model: _____
Serial Number: _____
Calibration Date: _____
Efficiency: _____%
Background: _____cpm
MDA: _____dpm/100cm^2
Source Check _____

SMEAR No.	LOCATION	ALPHA		BETA-GAMMA	
		Net cpm	dpm/100cm^2	Net cpm	dpm/100cm^2

Attachment 23



WALKOVER GAMMA RAY SCAN DATA SHEET FORM

Site:_____ Date: _____ Technician: _____

Scaler: _____ Probe: _____ Serial No. _____ Conversion _____

Background: _____ Indicates Maximum Gamma Rate on Grid Key

X-Grid Y-Grid	Grid Key	Gamma Range	Remarks/Coordinates of Biased Soil Samples (If Taken)

Battery Check _____volts Source Check_____

Attachment 24

WALKOVER GAMMA RAY SCAN DATA SHEET (LARGE AREA) FORM

Site: _____ Date: _____ Technician: _____

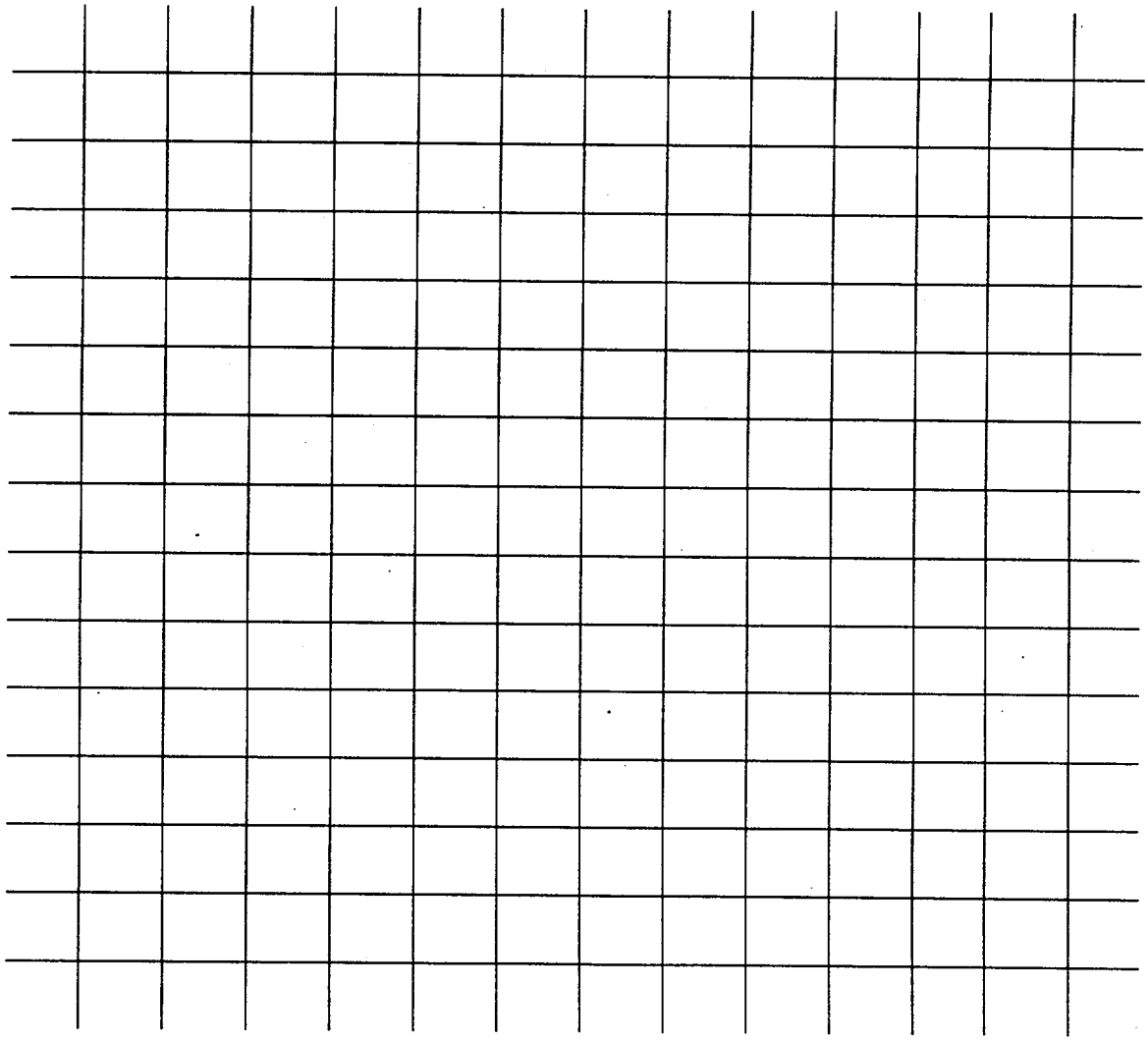
Scaler: _____ Probe: _____ No.: _____ Conversion: _____

Background: _____

Battery Check _____volts Source Check_____

Coordinates W - E

Coordinates S - N



Remarks: _____

Battery Chech _____volts Source Chech_____

_____

Attachment 25

NEAR SURFACE GAMMA RAY RADIATION SURVEY FORM

Site: _____ Surveyed By: _____

Area: _____ Recorded By: _____

_____ Bkg = _____ CPM Count Time _____ Min. Distribution:

_____ Bkg = _____ CPM Date: _____ To: _____ Date: _____

To: _____ Date: _____

Battery Check _____volts Source Check_____

(-X) W – Coordinates – E (+X)

(-Y) S – Coordinates – N (+Y)

Conversion Factors: Scaler Model: _____ Serial No.: _____

_____CPM = _____pCi/g Detector Model: _____ Serial No.: _____

_____CPM = _____pCi/g Scaler Model: _____ Serial No.: _____

Detector Model: _____ Serial No.: _____

Ground Conditions: _____

_____

Comments: _____

_____

_____

Attachment 26

GAMMA RAY EXPOSURE RATE SURVEY FORM

Site: _____ Location: _____

Date: _____ Survey No.: _____ Surveyed By: _____

PIC
Serial No.: _____ Calibration Factor _____mR/hr/cpm
Battery Check _____volts Source Check_____

INSTRUMENT AND DETECTOR

Scaler Model: _____ Detector Model: _____

Serial No.: _____ Serial No.: _____

Grid Point	µR/hr	Grid Point	µR/hr	Grid Point	µR/hr	Grid Point	µR/hr

Background Offsite Count Time

_____µR/hr _____

Attachment 27

SUBSURFACE GAMMA RAY RADIATION LOG FORM

Site: _____ Job No.: _____ Surveyors: _____

Area: _____ Recorder: _____

Count Time (Tc): _____ Depth Units: _____

Date: _____ Instrument: _____

Battery Check _____ volts Source Check _____

S (-Y) / W (-X)	Coordinates	N (+Y) / E (+X)

Hole No.	Hole No.	Hole No.	Hole No.	Hole No.	Hole No.	Hole No.	Hole No.	Hole No.	Hole No.	Hole No.
____	____	____	____	____	____	____	____	____	____	____

Scaler Model: _____ Serial No.: _____

Detector (Shielded): _____ Serial No.: _____

Scaler Model: _____ Serial No.: _____

Detector (Unshielded): _____ Serial No.: _____

Comments: _____

_____

Notes: Comments must be made for specific grid locations. Give coordinates of the location to which each comment applies.

Attachment 28

BETA PARTICLES AND GAMMA RAY DOSE RATE SURVEY FORM

Survey No.: _____ Date: _____ Time: _____

Site No.: _____ Area: _____ Surveyors: _____

Battery Check _____volts Source Check_____

INSTRUMENTS

Type Scaler/Ratemeter Serial No.	Detector Serial No.	Background, CPM	Conversion
			CPM=ImRAD/hr
			CPM=1μR/hr
			CPM=1μR/hr

MEASUREMENTS

Grid Point or Location	CPM Beta & Gamma	CPM Gamma	Beta & Gamma mR/hr	Gamma mR/hr	Net Beta mR/hr

Remarks: _____

_____

_____

Attachment 66

RADIATION/CONTAMINATION SURVEY LOG

Vista No.	Date	Time	Project	Description of Survey	No. of Pages	Tech Initials

ATTACHMENT 67
SURVEY CONTROL FORM

PART ONE

Survey Zone No.	Unit No.	Map Nos.	
Survey Location:			
Survey Type:	Term Prelim	Term Final	Other:
Grid Size(s):	1x1 M	2x2 M	3x3 M	Other:
Total No. Grid Blocks in Unit:		Number to Surveyed:	
Survey Instructions (Identify attached maps):			
Instructions Prepared By:		Date:	

PART TWO

ıte of Survey:	Surveyed By (Print):	Signature(s):

Instruments	Manufacturer	Model	Serial No.	Calibration Due	Eff.	Bkgrnd	MDA DPM
Micro-R							
Beta/Gamma (direct)							
Alpha (direct)							
Beta/Gamma (smears)							
Alpha (smears)							
Other							
Other							

Surveyor Notes:

No. of Data Sheets Attached:	Standard Maps:	Drawings:

Samples Collected:	No:	Yes:	From Blocks:

ATTACHMENT 67

Sample Description:

SURVEY CONTROL FORM
(Page 2)

PART THREE	
Survey Reviewed By:	
Comments:	
Approved for Data Entry (Signature):	Date / Time:

PART FOUR	
Data Entry Complete (Signature):	Date / Time:
Comments:	
Survey Package Verified Complete / Filed (Signature):	Date / Time:
Form File:	Revision Date: