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Administrative Information

Site: Rocky Flats Environmental Technology Site
Golden, Colorado

Project Name: Sampling of Roofing Material From Trailer T112B for Isotopic Analysis

Date Prepared: January ~~6~~ 12, 2000, Revision # 1 1/11/00

Date Effective: January ~~6~~ 12, 2000 1/11/00

Approvals

The undersigned have read and approved this sampling and analysis plan with respect to the objectives of the project.

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CLASSIFICATION OFFICE

1/33

ADMIN RECORD
IA-A-000323

Final
Sampling and Analysis Plan for Roofing Material from Trailer T112B for Isotopic Analysis

RF/RMRS-99-332
Revision # 1

January 12, 2000

2

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACRONYM LIST

ADM	Administrative Procedures Manual
AP2	Alpha Spectroscopy
ASD	Analytical Services Division
CAS	Commodore Advanced Sciences
CCR	Colorado Code of Regulations
CDPHE	Colorado Department of Public Health and Environment
COC	Chain of Custody
CPM	Counts Per Minute
DOT	Department of Transportation
DQO(s)	Data Quality Objectives
EPA	Environmental Protection Agency
FIDLER	Field Instrument for the Detection of Low Energy Radiation
KH	Kaiser Hill, L.L.C
MARSSIM	Multi Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
NORM	Naturally Occurring Radioactive Materials
PA	Protected Area
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
ppm	Parts Per Million
QA	Quality Assurance
QC	Quality Control
QE	Quality Engineer
RCRA	Resource Conservation and Recovery Act
REP	Radiological Engineering Procedure
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RIN	Report Identification Number
RMRS	Rocky Mountain Remediation Service, L.L.C
ROI	Radiological Operating Instructions
RSP	Radiological Safety Practices
SAP	Sampling and Analysis Plan
SOPs	Standard Operating Procedures
TSA	Total Surface Activity

LIST OF STANDARD OPERATING PROCEDURES (SOPs)

CAS SOP-003	Sampling for Waste Characterization for General Sampling Activities at RFETS
PRO-477-RSP-16.03	Radiological Samples of Building Media
3-PRO-141-RSP-09.01	Unrestricted Release of Property, Material, Equipment and Waste
5-210000-OPS-FO.11	Field Communications
2-S47-ER-ADM-05.14	Use of Field Logbooks and Forms
RF/RMRS-98-200	Evaluation of Data for Usability in Final Reports

1.0 INTRODUCTION

Trailer T112B was moved to Central Avenue and Fourth Street, behind the northwest corner of Bldg. 112 in 1990 or 1991 from the Bldg. 771 trailer park. At this time the interior was refurbished. T112B has a nearly full-length wooden deck with a sloped roof on its south side. The size of T-112B is approximately forty-two (42) by ten (10) feet or four hundred twenty (420) square feet. The siding and the skirting consist of enamel on aluminum. It has served as a site for folding laundry, telecommunications office space, and storage of telecommunications equipment. It is presently unoccupied and is located at the new sanitary landfill.

Asbestos characterization data exist for the interior of the trailer, and show asbestos in the floor tile mastic. Hazardous chemicals were not known to be used or stored in the trailer. The trailer has not been characterized for use of lead-based paint.

The purpose of this Sampling and Analysis Plan (SAP) is to collect data to satisfy data gaps regarding radiological contamination of the roofing material of T-112B.

Due to past RFETS experience with the unrestricted release of similar structures, (i.e. T690 trailer complex), a more representative number of samples will be taken from the roofing material at T112B to better distinguish the previous high level of alpha readings, reference radiological surveys and sampling results in Appendix 1. A total of twenty-two (22) samples will be collected.

2.0 DATA QUALITY OBJECTIVES (DQOs)

Decisions must be made as to whether Trailer T-112B, is radiologically contaminated or eligible for free-release from the site. These decisions will be based on both radiological surveys and radiochemistry samples. This SAP and the DQOs within it only address the radiochemical characterization needs of the project. Radiological surveys will be performed to support the sampling effort, not to implement MARSSIM survey requirements. MARSSIM survey requirements have already been completed. Based on visual inspections and historical use of the trailer for administrative purposes only, potential of chemical hazards within or on the trailers has been ruled-out.

2.1 The Problem

The quantity and types of radioactive contamination present in and on the trailer are not known with adequate confidence to ensure compliance with free-release criteria; therefore, additional measurements must be taken to properly characterize the trailer as contaminated or not contaminated. All areas of trailer T-112B were characterized through previous radiological surveys; however, radionuclides of interest within bulk material on trailer rooftop T-112B must be established through radiochemical analysis because initial alpha readings, (fixed contamination), were elevated and could not be decayed to levels below free release, (see Appendix 1), indicating contamination.

However, based on site history and process knowledge, naturally occurring radioactive materials (NORM) are suspected, particularly Po-210, as a source of elevated alpha readings. The purpose of this SAP is to determine whether the trailer is contaminated primarily with Am-241 or NORM.

2.2 Identification of Decisions

What types and quantities of radioactive contamination exist in the bulk matrix of roofing materials, and if present, is contamination above or below free-release levels for the radionuclides of interest?

1) Is the rooftop radiologically contaminated by DOE-added radionuclides?

2) Are elevated survey (e.g. total surface activity, (TSA)) measurements due to NORM, especially Po-210, Po-214 and/or Po-218?

2.3 Inputs to the Decisions

Inputs to the decisions include

- Radiochemistry results (U-233/234, U-235, U-238, Am-241 and Pu-239/240 and Po-210) from twenty (20) samples of interest on T-112B roof (with two (2)additional samples taken for matrix investigation only),
- Radon progeny or other potential isotopes contributing to the elevated alpha readings recorded during previous radiological field surveys measured by both radiochemical (Po-210) and AP-2 (Po-218 and Po-214).
- quality assurance aspects of the data, including precision, accuracy, representativeness, completeness, and comparability (i.e., the PARCC parameters),
- unrestricted release criteria – DOE Order 5400.5

2.4 Definition of the Boundaries

Three-dimensional boundaries for defining the levels and extent of radioactive contamination are restricted to the trailer rooftop exterior referenced above (42' x 10').

Due to inconclusive radiochemistry results and elevated field surveys from the rooftop of the T112B trailer, the rooftop is now considered a separate Survey Unit ("T112B Roof") for the purpose of implementing a free-release sampling scheme based on MARSSIM methodology (impacted Class 3).

2.5 Decision Rules

Comparison of field results with action levels will be performed by summing all Uranium (U) isotope results and comparing the total with U action levels, (i.e. 5000 dpm/100cm^2). Likewise with the transuranic radionuclides, the sum of all isotopic results for transuranic radionuclides (i.e. Pu-239/240, Am-241,) will be compared to the transuranic action levels (e.g. 100 dpm/100cm^2).

1) If all total surface contamination results, as measured through media samples, are below the (total, or fixed) surface contamination thresholds as defined in DOE Order 5400.5 and the RFETS Radiological Control Manual, the survey unit may be free-released. Otherwise, the survey unit is considered radiologically contaminated, OR the

square-meter that exceeds free-release criteria may be further sampled to attain an average value for the square-meter area.

> NOTE: If TSA for a square-meter area is averaged (based on additional samples) using three or more samples taken from the square-meter area, and the average is less than the free-release thresholds noted above, the square-meter area is cleared for free-release purposes. Otherwise, the survey unit is considered radiologically contaminated.

2) If there is no DOE-added radioactive contamination above release limits based on the decision above, and NORM is detected at activities comparable with field measurements, then NORM are concluded as the cause for elevated alpha-survey (TSA) results derived from hand-held instrumentation.

2.6 Limits on Decision Errors

Based on earlier results of high alpha readings, a statistical sampling of the roof is to be performed using the MARSSIM concept.

2.7 Optimization of the Sampling Design

If results indicate contamination levels greater than free-release levels, the survey unit will be considered low-level waste.

3.0 SAMPLING AND ANALYSIS

T112B has a heavily oxidized metal roof. Previous surveys of site trailers of similar age and construction have exhibited high alpha count rates due to the deposit of NORM in this porous oxide layer. A single sample from previous analysis of roofing material samples from T-112B exhibited elevated Am-241 activity as measured by alpha spectroscopy.

3.1 Radiological Surveys/Sampling

Samples will be collected using the sampling techniques described in CAS SOP-003, *Commodore Advanced Sciences, Waste Characterization Procedure* and PRO-477-RSP-16.03 Section 7.4.3, *Radiological Samples of Building Media* for roof samples. Roofing material will be removed utilizing tin snips. The roof consists of oxidized aluminum with a layer of fiberglass insulation beneath it. Wide mouth glass sample jars will be used to collect samples, and signed custody seals will be applied after sample collection. Quality control samples, such as one duplicate, and one rinsate are required for this effort.

3.2 Measurement Frequencies

Consistent with MARSSIM methodology implemented elsewhere at RFETS (specifically the Building 779 D&D Project), the same initial input parameters were assumed to calculate sample quantities for the Survey Unit (Attachment 2). Following verification and validation of the sample results, the real data will be re-computed in the MARSSIM algorithm (MARSSIM § 5.5.2.3 and MARSSIM Table 5.5) to determine whether enough samples were taken to achieve 95% confidence in the decisions. Recalculation of the

MARSSIM sample quantity is consistent with the EPA DQO process, where sampling designs are optimized through the use of the latest representative data.

Trailer 112B Roof Dimensions

Length (ft) = 42
Width (ft) = 10

Area (ft^2) = 420

MARSSIM Equation 5-8 (for a *square* grid)

L=Sqrt(A/n)

Where: A= area = 420 ft^2
n = # samples = 15

L = length = 5.3 Ft
grid spacing = 5.3 Ft

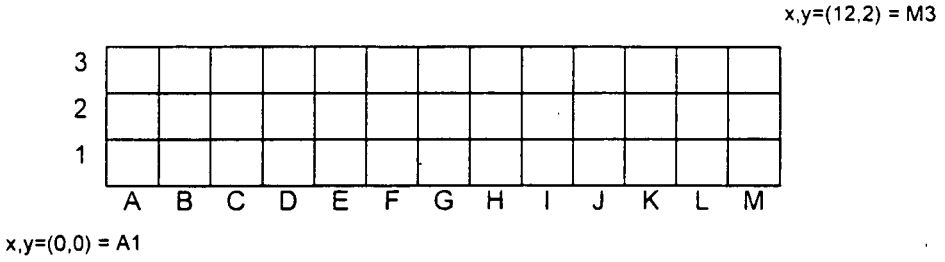
(Rounding down, to maximize grid density, yields)
grid spacing = 5 Ft

Table 1 MARSSIM Minimal Grid Spacing Calculation for Survey Unit T112B-Roof.

3.3 Designating Measurement Locations

The grid specifications, (i.e. identified in Appendix 2), developed for the rooftop area sampling locations are presented in Table 1 and Figure 1. Table 1 presents the derivation of the grid spacing. The reference grid system previously used on the roof consisted of a 1 meter square spacing, and because it established a more conservative approach than the calculated spacing given above (i.e. a 1 meter spacing provides a higher grid density) the original 1 meter spaced referenced coordinate system will be used for random collection of samples. Figure 1 depicts the general shape of the grid coupled with directions on how to implement the grid spacing on the roof surface. If H&S restrictions preclude acquiring samples in the middle portion of the roof, location coordinates (resulting from the random number generator) falling in the middle portion will be discarded as they arise, and only random samples around the roof perimeter will be acquired.

Sample locations are at lower left corner of each cell unless noted otherwise, dimensions of each cell shown are 1m x 1m.



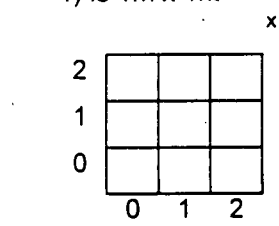
DIRECTIONS

1) assign an origin (point) on the rooftop that corresponds to the grid given above
2) Use Table A2-1 to acquire the random numbers.
3) Use the first number pair (x,y coordinates) that can be physically located and sampled given the cells above.
   For example, if the 1st coordinate value is inaccessible, go to the next coordinate value on the table.

Figure 1 MARSSIM Grid Dimensions and Directions.

Sample locations are at **center of each sub-cell** unless noted otherwise

Dimensions of entire area (**cell M1** from "Survey Points", App. 1) is 1m x 1m



DIRECTIONS

1) overlay the sub-cells, shown above, onto Cell M1
2) Use Table A2-1 to acquire the random numbers.
3) Use the first number pair (x,y coordinates) that can be physically located and sampled given the sub-cells above.
   For example, if the 1st coordinate value is inaccessible, go to the next coordinate value on the table.

Figure 2 MARSSIM Grid Dimensions and Directions for Grid M1 (only)

3.4 Surface Scans

Surface scans of the Survey Unit, per MARSSIM guidance, were previously performed and are included in Appendix 1.

3.5 Surface Activity Measurements

Total Surface Activity measurements of the Survey Unit, per MARSSIM guidance, were previously performed and are included in Appendix 1.

3.6 Surface Media Sampling

The following steps will be performed:

1. A grid coordinate will be laid out and marked for sampling as depicted in Figures 1 and 2.
2. Pre-sampling and post-sampling direct scans and smears (e.g. for removable contamination) will be taken for each randomly selected node or grid coordinate to identify elevated readings for comparison to previous surveys and to infer contribution from short lived Rn daughters;
3. AP-2 field alpha spectrum for the two or three (depending upon readings and time available) randomly selected grid coordinates with the highest direct alpha readings on the Electra instrument will be collected to give immediate, preliminary information regarding short lived Rn daughters and Am-241. Locations of AP-2 spectra will be recorded by en-scribing with a sharpe pen, such that the marking does NOT interfere with the surface being measured.
4. Fifteen (15) random samples distributed over the entire roof, plus three (3) in square M1 (location of Am-241 hit on previous survey, Figure 3.2), plus one (1) QC duplicate and one (1) rinsate will be taken. Each sample consists of one 4.0" x 2.0" square for radionuclide analysis (Pu-239/240, Am-241, U-233/234, U-235, U238, and Po-210).
5. Two (2) additional random samples as above in #4 will be taken for matrix investigation only (see below).

Sample Type/Purpose	# of Samples	Sampling Location
Radionuclides	15	Random per MARSSIM, Figure 1
Grid M1 (Earlier hit of Am-241)	3	Random, & average per DOE Order 5400.5, Figure 2
QC duplicate sample	1	Event number six
QC Rinsate sample	1	Event number twenty-one (per COC)
Matrix Investigation	2	Event number one- (per COC)
Total Number of Samples	**22**	

Table 2 Summary of Total Number of Samples for T-112B Roof

The individual weight of all squares will be determined using a calibration-certified scale and recorded. Additionally, the individual length and width of each square will be recorded in inches. Samples must be as close as possible to 4" x 2" in size.

These samples will be sent to an off site laboratory and analyzed for the seven radionuclides of concern (Pu-239/40, Am-241, U-233/234, U-235, and U-238), as well as Po-210. The analytical laboratory Statement of Work will be modified such that a 2" x 2" square cut by the laboratory is tare weighed and digested, and then split in half after digestion, such that one half goes for Po-210 analysis and the other half goes for analysis of Pu-239/40, Am-241, U-233/234, U-235, and U-238. (This is necessary due to the fact that the two analyses cannot be run on the same material).

In order to allow the laboratory to evaluate precision with respect to dissolution and tracer properties to such a sample that will be split in half, two random samples will be provided for matrix investigation only. These will be the last two samples taken, and "Matrix Investigation" will be noted by their RIN numbers in the sample log.

Further, in addition to providing a concentration-based result (i.e. pCi/gm), the laboratory will be required to provide a total activity per isotope for the entire sample.

3.7 Background Subtraction

No background subtractions are performed on the media sample results. This treatment of background data results in conservative estimates or radiological contamination, i.e., potentially biasing estimates of contamination at levels greater than actually exist. Local area backgrounds measurements will be subtracted from associated field surveys.

3.8 Investigation Action Levels

Table 3
Impacted Class 3 Survey Unit Investigations

Condition [1]	Follow-up Actions*
1) Any total surface contamination or media sample result exceeding the $DCGL_W$.	1) Reclassify and resurvey.
2) Any scan result exceeds 75% of the $DCGL_{EMC}$.	2) Perform a total surface contamination measurement at the flagged area to assure the actual value is less than the $DCGL_{EMC}$. If not, the area must be remediated, reclassified and resurveyed.
3) The average value for total surface contamination or media sample results for the survey unit exceeds 75% of the $DCGL_W$.	3) Reclassify and resurvey (remediation may also be required).
4) Any single removable contamination result exceeds 20 dpm/100 cm^2.	4) Remediate, reclassify and resurvey.

[1] Confirmed as DOE – Added Radionuclides (Am-241, Pu-239/240, U-233/234, U-235, U-238)

3. 9 Isolation Controls

Because the project's data will be used to demonstrate compliance with PDS requirements, isolation controls will be implemented. Postings and/or physical barriers will provide visible indicators of the areas surveyed and for which isolation controls have been established. These postings will consist of signs, ropes, or other similar barriers.

The potential for the spread of contamination or the movement of radioactive material is not significant for the T112B roof, and is therefore classified as a Level 2 isolation control. Level 2 control shall be implemented based on

- project personnel briefings on isolation controls at the pre-evolution,
- posting of labels at the trailer's perimeter.

Additional isolation controls as identified under the RWP and as determined by radiological engineering.

4.0 SAMPLE DESIGNATION

Each sample will be assigned a unique number in accordance with the RFETS Analytical Services Division (ASD) requirements. The unique sample number will be broken down into the following three parts:

- Report Identification Number (RIN)
- Event Number
- The Bottle Number

The first part of the number will be the RIN, which is assigned by the ASD. The RIN is used by the ASD to track and file analytical data. It is expected that one RIN will be assigned, however, if the project is not completed quickly, ASD may assign additional RINs. The RIN will be a seven digit alphanumeric code starting with "00" for 2000. The RIN will be followed by a dash "-" and then the event number. The event number is a three digit code, starting with "001" under the RIN, and will be sequential. Each typical sample location will have a unique event number under the RIN. The event number will be followed by a period "." and then the sequential bottle number. The bottle number will be used to identify individual sample containers collected at the same location and same event number.

In addition to the sample numbering scheme above, additional information will be collected with respect to each sample. This additional information will include:

- Sample type
- Location code

5.0 SAMPLE HANDLING AND DOCUMENTATION

Sample custody will be maintained and documented using RFETS chain of custody forms. Sampling equipment (e.g., utility knife, tin snips) will be decontaminated between

sampling locations. Decontamination will be performed following procedure CAS SOP-003 using triple wash and rinse process in conjunction with Alconox or Liquinox detergent and distilled or de-ionized water followed by wiping with a Kim-wipe™. Sampling information shall be documented on field logbooks as per procedure 2-S47-ER-ADM-05.14. The originator shall authenticate (legibly sign and date) each completed hardcopy of the data. A peer reviewer, someone other than the originator, shall perform a review of the logsheet/notebook. The peer reviewer shall authenticate each hardcopy completed by the originator. Any modifications shall be lined-through, initialed, and dated by the reviewer (in ink). The QA Records for the project include the logbook and chain-of-custody forms.

6.0 QUALITY ASSURANCE

All components and processes within this project will comply with the RMRS Quality Assurance Program Description RMRS-QAPD-001, Revision 3 (RMRS, 1999a), which is consistent with the K-H Team QA Program. Field sampling quality control will be conducted to ensure that data generated from all samples collected in the field for laboratory analysis represents the actual conditions in the field. The confidence levels of the data will be maintained by the collection of QC samples, consisting of a duplicate sample. Analytical and field data that is collected in support of this SAP will be evaluated through a data quality assessment using EPA guidance and that developed by the RMRS procedure RF/RMRS-98-200 Evaluation of Data for Usability in Final Reports. PARCC parameters are generally described as follows:

- **Precision** – A quantitative measure of data quality that refers to the reproducibility or degree of agreement among replicate or duplicate measurements of a parameter. The closer the numerical values of the measurements are to each other, the lower the relative percent difference and the greater the precision.
- **Accuracy** – A quantitative measure of data quality that refers to the degree of difference between measured or calculated values and the true value of a parameter. The closer the measurement to the true value, the more accurate the measurement.
- **Representativeness** – A qualitative characteristic of data quality defined by the degree to which that data absolutely and exactly represents the characteristics of a population. Representativeness is accomplished by obtaining an adequate number of samples from appropriate spatial locations within the medium of interest. Samples will be collected by the RFETS Commodore Advanced Sciences, (CAS), sample team in accordance with the following procedures:

    - CAS SOP-003, *Commodore Advanced Sciences, Waste Characterization Procedure*,
    - PRO-477-RSP-16.03 Section 7.4.3, *Radiological Samples of Building Media*, Roof Samples Revision 0 dated 9/30/99
    - MARSSIM, NUREG 1575, Dec. 1997

  Radiological instrumentation planned for the project is controlled by RMRS Radiological Operations. Instruments to be used on the project will be the following:

- Eberline SAC-4, and BC-4, for measurement of alpha and beta in dpm/100cm².
- SAIC AP-2 for identifying existing radon progeny radionuclides (i.e. Po-214/218) in (MeV)
- NE – Electra w/ DP-6 probe for identifying total surface activity (TSA) in dpm/100cm².

This equipment is adequate for producing the required data and performance requirements which comply with DOT requirements. All equipment is daily source checked and calibration procedures are followed per Radiological Safety Practices, (RSP) procedures and requirements.

K-H Analytical Services Division (ASD) manages contractual requirements with onsite and offsite vendors for radiochemistry data. The offsite analytical laboratory vendor, General Engineering Laboratories, will comply with the following requirements for the following isotopic analysis:

  - Task order #TR01A87 to analyze isotope Po-210 and
  - RC01-B.3 for analysis of Pu-239/240, Am-241,U-233/234, U-235, and U-238.

- **Completeness** – A quantitative measure of data quality expressed as the percentage of valid or acceptable data obtained from a measurement system. Real samples and QC samples will be reviewed for the data usability and achievement of internal DQO goals.
- **Comparability** – A qualitative measure defined by the confidence with which one data set can be compared to another. MARSSIM methodology sets these parameters by comparing the sum of field data results with Action Levels.

7.0 PROJECT ORGANIZATION

Table 4 lists the responsible personnel assigned to this project, their responsibilities and contact information.

Table 4 - Personnel Supporting the T112B Roofing Characterization

Name	Responsibility	Phone	Pager	Radio
Tom Lindsay	Project Manager	5705	None	3757
Dave Barnes	Radiological Engineer	5352	212-6541	3759
Brian Maria	Industrial Hygiene	2878	212-6531	
Dan Lippencott Michelle Hershey John Goolsby Craig Huyett	Commodore Sample Team	5267	212-3129	3502
Jim Moore	Quality Assurance	4243	212-6612	None
Marla Broussard	Characterization Manager	6007	212-6261	None
Dick Reed Paul Vestal	Radiological Control Technician	2397	None	None
Letty Cooper	Radiological Operations Supervisor	2397	212-2333	3208

8.0 REFERENCES

RMRS, 1999a, RMRS Quality Assurance Program Description RMRS-QAPD-001, Revision #3

APPENDIX 1

PREVIOUS SURVEYS/SCANS & SAMPLE RESULTS FOR T-112B TRAILER

APPENDIX 2

MEDIA SAMPLING PARAMETERS PER MARSSIM GUIDANCE

RANDOM NUMBERS GENERATED FOR T112B ROOF SAMPLE LOCATIONS

GRID TYPE							
Rectangle 4:1		Rectangle 4:1		Rectangle 4:1		Rectangle 4:1	
Coordinate value		coordinate value		coordinate value		Coordinate value	
(x)	(y)	(x)	(y)	(x)	(y)	(x)	(y)
6	1	1	1	5	2	5	1
3	2	0	1	0	0	1	1
2	1	3	1	3	2	1	1
8	1	8	0	4	2	7	2
3	0	1	0	0	0	4	2
2	1	0	2	0	1	3	2
2	0	1	2	2	1	6	0
8	1	5	1	1	0	6	2
6	1	6	0	7	1	6	1
1	1	1	0	5	2	0	1
0	2	8	0	3	1	5	1
4	2	7	1	3	1	2	1
5	2	0	1	0	1	3	1
4	1	8	2	8	1	1	2
0	1	5	0	8	2	3	0
8	1	6	2	8	1	3	1
3	1	5	2	7	0	5	2
7	1	7	2	4	0	0	1
8	1	3	0	3	1	5	0
3	1	1	1	0	2	2	0
3	1	1	0	4	0	7	2
0	1	5	1	3	1	5	2
3	2	1	0	4	2	1	1
5	0	5	0	7	2	0	2
6	2	4	0	3	1	6	2
2	2	0	1	2	2	6	1
3	0	0	2	1	0	8	0
3	0	4	2	2	1	1	1
0	1	5	0	7	0	1	1
3	1	2	1	6	2	6	1
5	1	5	1	5	1	1	2
5	0	4	0	4	1	1	1
6	2	7	1	0	0	8	2
6	2	8	1	0	0	5	2
7	0	4	2	0	2	3	0
7	2	0	0	4	1	0	1
7	1	3	2	1	1	0	2
5	0	5	2	6	0	1	1
2	0	3	2	6	1	7	0

Table A2-1. Random Coordinates for Sample Location Selections.

Media Surface Activity Measurement Calculation Worksheet
Survey Unit T112B-Roof

Step 1: Determine the relative shift ($\Delta\delta$) in accordance with MARSSIM, Section 5.5.2.3, as follows:

Note: Since a reference area background subtraction will not be used for any measurements and since the equation in Section 5.5.2.3 results in a larger number of samples than the equation in Section 5.5.2.1 for a relative shift of 2.0, the equation in Section 5.5.2.3 will be used to estimate the samples needed:

$\Delta/\delta = (DCGL_{media} - LBGR_{media})/ SD_{media}$

$\Delta/\delta_{transuranics} = 2.0 = (100\ dpm/100cm^2 - 40\ dpm/100cm^2)/30\ dpm/100cm^2$
$\Delta/\delta_{uranium} = 2.0 = (5000\ dpm/100cm^2 - 2000\ dpm/100cm^2)/1500\ dpm/100cm^2$

Where:

Δ/δ	is the relative shift or the resolution of measurements in units of measurement uncertainty (MARSSIM recommends a value between 1and 3)
$DCGL_{media}$	is the total surface activity derived concentration guideline value (DOE Order 5400.5 total surface contamination limit equals 100 dpm/100cm^2 for transuranics and 5000 dpm/100cm^2 for uranium, per the B779 Cluster Radiological Closeout Survey Plan)
$LBGR_{media}$	is the lower bound of the gray region – the lower bound of the range of values of the parameter of interest in a survey unit where the consequences of making a decision error is relatively minor. The $LBGR_{media}$ was adjusted to obtain a relative shift between 1 and 3 (i.e., 40 dpm/100cm^2 for transuranics and 2000 dpm/100cm^2 for uranium).
SD_{media}	is the estimated standard deviation of the media surface activity measurements (MARSSIM recommends assuming a 30% coefficient of variation if scoping or characterization data is not available) (i.e. 30 dpm/100cm^2 for transuranics and 1500 dpm/100cm^2 for uranium).

Step 2: Determine the Sign P value by looking up the relative shift ($\Delta\delta$) in Table 5.4 of MARSSIM (the Sign P value is the estimated probability that a random measurement from the survey unit will be less than the DCGL when the survey unit median is actually at the LBGR). The Sign P value from Table 5.4, equals 0.977250 for a relative shift of 2.0.

Step 3: Determine the number of media surface activity measurements for the applicable survey unit using the following MARSSIM, Section 5.5.2.3 formula that is based on Plutonium contaminants not being present in the background:

$N = (1.645 + 1.645)^2 / 4(Sign\ P - 0.5)^2$

$N = (1.645 + 1.645)^2 / 4(0.977250-0.5)^2 = 11.88$

Where:

1.645	is the alpha and beta decision error value (95% confidence) per the B779 Cluster Radiological Closeout Survey Plan
Sign P	equals 0.977250

Step 4: Increase N by 20% to allow for missing or invalid data points per MARSSIM, Section 5.5.2.3; also consistent with the value given in Table 5.5, for no background scenarios at 5% error for alpha and beta, respectively.

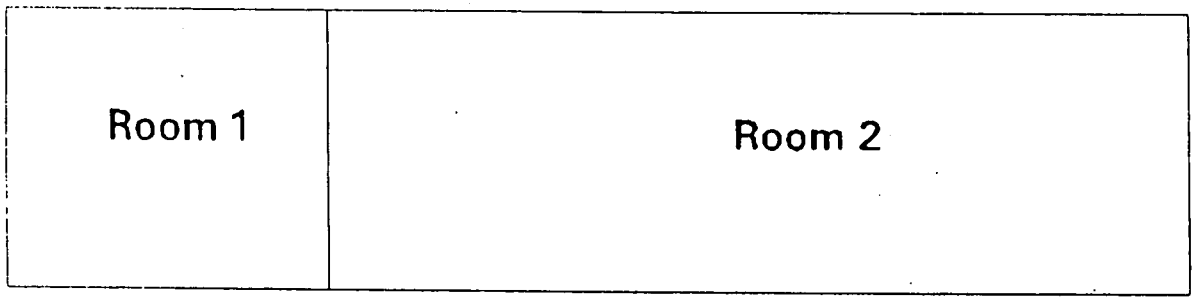
$N = 11.88 * 1.2 = 14.25 \approx 15$, when rounded-up.

Conclusion: A minimum of 15 media surface activity measurements will be obtained in the referenced survey unit.

11/23

bfloorplan.xls

Building T112B Floorplan



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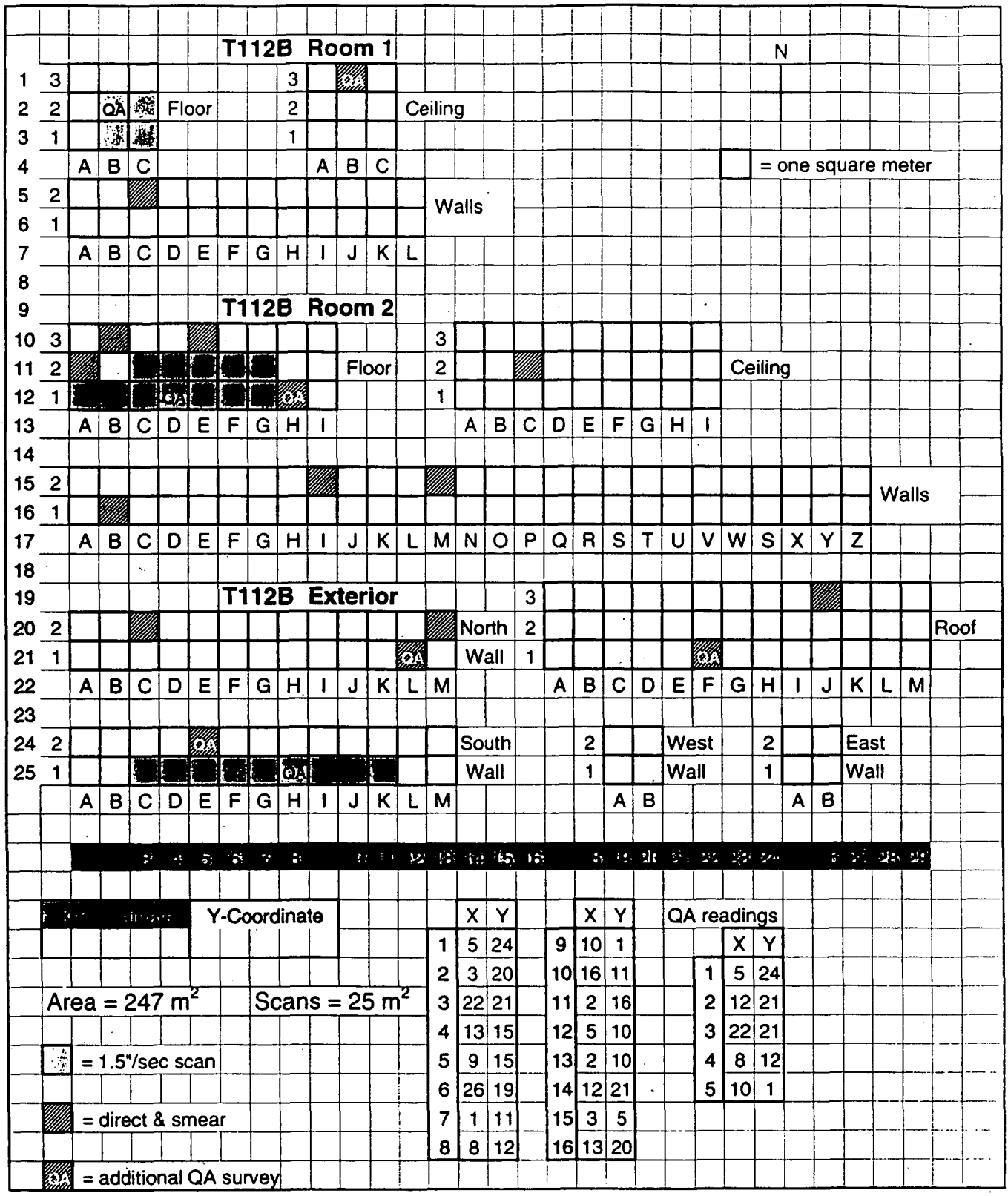
112 Trailers PDS
Unit B - T112B
SURVEY POINTS



	X	Y
1	5	24
2	3	20
3	22	21
4	13	15
5	9	15
6	26	19
7	1	11
8	8	12

	X	Y
9	10	1
10	16	11
11	2	16
12	5	10
13	2	10
14	12	21
15	3	5
16	13	20

	X	Y
1	5	24
2	12	21
3	22	21
4	8	12
5	10	1

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RS FORMS 07.02-01

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

INSTRUMENT DATA

Mfg.		Mfg.		Mfg.				
Model		Model		Model				
Serial#		Serial#		Serial#				
Cal Due	N/A	Cal Due	N/A	Cal Due	N/A			
Bkg.	cpm	Bkg.	cpm	Bkg.				
Efficiency	%	Efficiency	%	Efficiency				
MDA	dpm	MDA	dpm	MDA				
Mfg.		Mfg.		Mfg.	NEtech			
Model		Model		Model	Electra			
Serial#		Serial#		Serial#	1682			
Cal Due	N/A	Cal Due	N/A	Cal Due	2/4/00			
Bkg.	cpm	Bkg.	cpm	Bkg.	1	319	cpm	
Efficiency	%	Efficiency	%	Efficiency	22.2	30.1	%	
MDA	dpm	MDA	dpm	MDA	33	285	dpm	

Survey Type: CONTAMINATION SURVEY
Building: T112B roof resurvey
Location: 280 Yard
Purpose: MARSSIM Release Survey

RWP #: N/A

Date: 08-16-99 Time: 12:00

RCT: Hersey (Print name) L Hersey (Signature)

RCT: Espinoza (Print name) Espinoza (Signature)

PRL #:

Comments: Scan Results Are Of Hi Reading In Each Grid.

SURVEY RESULTS

Swipe #	Location/Description (Results in DPM/100CM²)	Removable Alpha	Removable Beta	Total Alpha	Total Beta	Swipe #	Location/Description (Results in DPM/100CM²)	Removable Alpha	Removable Beta	Total Alpha	Total Beta
1	M1			185	425	21	F3			189	412
2	L1			153	352	22	E3			171	<285
3	K1			167	452	23	D3	N/A		149	309
4	J1			194	<285	24	C3			162	<285
5	I1			189	349	25	B3			158	346
6	H1			149	422	26	A3			135	<285
7	G1			167	429	27					
8	F1			131	322	28					
9	E1			162	452	29					
10	D1	N/A		171	442	30					
11	C1			167	422	31					
12	B1			171	405	32					
13	A1			185	415	33	N/A				
14	M3			167	329	34					
15	L3			153	355	35					
16	K3			162	392	36					
17	J3			153	419	37					
18	I3			171	342	38					
19	H3			149	389	39					
20	G3			167	329	40					

Date Reviewed: 8/17/99 RS Supervision: S Engelhard (Print Name) (Signature)

Rev. 05/98

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RS FORMS 07.02-01

Page 1 of 2.

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

INSRUMENT DATA

Mfg. EBERLINE	Mfg. EBERLINE	Mfg. NE
Model SAC-4	Model SAC-4	Model ELECTRA
Serial# 861	Serial# 842	Serial# 1425
Cal Due 12/7/99	Cal Due 12/9/99	Cal Due 8/25/99
Bkg. 0.3	Bkg. 0	Bkg. 2 / 548
Efficiency 0.33	Efficiency 0.33	Efficiency .21 / .316
MDA <20	MDA <20	MDA 44 / 366
Mfg. EBERLINE	Mfg. EBERLINE	Mfg.
Model BC-4	Model BC-4	Model
Serial# 704	Serial# 702	Serial#
Cal Due 9/25/99	Cal Due 11/20/99	Cal Due
Bkg. 36	Bkg. 43	Bkg.
Efficiency 0.25	Efficiency 0.25	Efficiency
MDA <200	MDA <200	MDA

Survey Type: CONTAMINATION
Building: T-112 B
Location: Roof
Purpose: Pre & Post-Job Survey

RWP #: N/A

Date: 07/21/99 Time: 1370

RCT: S. Jablkowski / [signature] / [redacted]
Print name / Signature

RCT: N/A / / /
Print name / Signature / Emp. #

PRL #: NA

Comments: Pre & Post-Job survey on roof for sampling.

(SEE MAP)

SURVEY RESULTS — Map

Swipe #	Location/Description Results in DPM/100sq cm	Removable Alpha	Removable Beta	Total Alpha	Total Beta	Swipe #	Location/Description Results in DPM/100sq cm	Removable Alpha	Removable Beta	Total Alpha	Total Beta
1	See Map	<20	<200	<44	<366						
2		<20	<200	<44	<366						
3		<20	<200	<44	<366						
4		<20	<200	12	<366						
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

7-21-99

Date Reviewed: 7/21/99 RS Supervision: S Engelhard / [signature] / [redacted]
Print Name / Signature

Rev. 05/98

23

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RS FORMS 07.02-01

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

INSTRUMENT DATA

Mfg.	Eberline	Mfg.	Eberline	Mfg.			
Model	SAC-4	Model	SAC-4	Model			
Serial#	835	Serial#	824	Serial#			
Cal Due	10/26/99	Cal Due	10/13/99	Cal Due	N/A		
Bkg.	0.1 cpm	Bkg.	0.1 cpm	Bkg.			
Efficiency	33 %	Efficiency	33 %	Efficiency			
MDA	6.5 dpm	MDA	6.5 dpm	MDA			
Mfg.	Eberline	Mfg.	Eberline	Mfg.	NEtech		
Model	BC-4	Model	BC-4	Model	Electra		
Serial#	700	Serial#	770	Serial#	2356		
Cal Due	10/22/99	Cal Due	1/7/00	Cal Due	8/18/99		
Bkg.	39 cpm	Bkg.	37 cpm	Bkg.	2	374 cpm	
Efficiency	25 %	Efficiency	25 %	Efficiency	21.4	30.0 %	
MDA	200 dpm	MDA	200 dpm	MDA	43	309 dpm	

Survey Type: CONTAMINATION SURVEY
Building: T112B
Location: 280 Yard
Purpose: MARSSIM Release Survey

RWP #: N/A

Date: 08-09-99 Time: 15:30

RCT: Hersey / Hersey
Print name Signature

RCT: Espinoza / Espinoza
Print name Signature

PRL #:

Comments: All Scans were approx. around background except for the ones noted below

#15 & #16 ave. 225 dpm/100cm2 alpha and 420 dpm/100cm2 beta fixed plus remov.

Alpha removable was a two minute count.

hi readings on scan

#15= 150 dpm alpha, <309 dpm beta

#16= 220 dpm alpha, <309 dpm beta

SURVEY RESULTS

Swipe #	Location/Description (Results in DPM/100CM²)	Removable Alpha	Removable Beta	Total Alpha	Total Beta	Swipe #	Location/Description (Results in DPM/100CM²)	Removable Alpha	Removable Beta	Total Alpha	Total Beta
1	T112B ROOM 1 CEILING B3 *	<6.5	<200	<43	<309	QA	#1			<43	<309
2	T112B ROOM 1 WALL C2	<6.5	<200	<43	<309	QA	#6			<43	<309
3	T112B ROOM 2 FLOOR A2	<6.5	<200	<43	<309	QA	#12	N/A		<43	<309
4	T112B ROOM 2 FLOOR B3	<6.5	<200	<43	<309	QA	#14			<43	<309
5	T112B ROOM 2 FLOOR E3	<6.5	<200	<43	<309	QA	#15			51	<309
6	T112B ROOM 2 FLOOR H1 *	<6.5	<200	<43	<309						
7	T112B ROOM 2 CEILING C2	<6.5	<200	<43	<309						
8	T112B ROOM 2 WALL B1	<6.5	<200	<43	<309						
9	T112B ROOM 2 WALL I2	<6.5	<200	<43	<309						
10	T112B ROOM 2 WALL M2	<6.5	<200	<43	<309						
11	T112B EXTERIOR NORTH WALL C2	<6.5	<200	<43	<309		N/A				
12	T112B EXTERIOR NORTH L1 *	<6.5	<200	<43	<309						
13	T112B EXTERIOR NORTH WALL M2	<6.5	<200	<43	<309						
14	T112B EXTERIOR SOUTH WALL E2 *	<6.5	<200	<43	<309						
15	T112B EXTERIOR ROOF F1 *	<6.5	<200	61	<309						
16	T112B EXTERIOR ROOF J3	<6.5	<200	220	<309						
	N/A										

Date Reviewed: 8/13/99 RS Supervision: S Engelhard / Engelhard
Print Name Signature

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

INSRUMENT DATA

Mfg.	SAIC	Mfg.	Mfg.
Model	AP-2	Model	Model
Serial#	A146	Serial#	Serial#
Cal Due	Oct-99	Cal Due	Cal Due
Bkg.	N/A	Bkg.	Bkg.
Efficiency	N/A	Efficiency	Efficiency
MDA	N/A	MDA	MDA
Mfg.		Mfg.	Mfg.
Model		Model	Model
Serial#		Serial#	Serial#
Cal Due		Cal Due	Cal Due
Bkg.		Bkg.	Bkg.
Efficiency		Efficiency	Efficiency
MDA		MDA	MDA

Survey Type: Alpha Spectroscopy
Building: T112B
Location: Metal Roof
Purpose: RSP/RF RCM Compliance

RWP #: N/A

Date: 07/21/99 Time: Day

RCT: R. E. Read / [signature] / [redacted]
Print name Signature Emp. #

RCT N/A / N/A / N/A
Print name Signature Emp. #

PRL #: N/A

Comments: 82 gross Counts is barely adequate for spectrum data.

SURVEY RESULTS

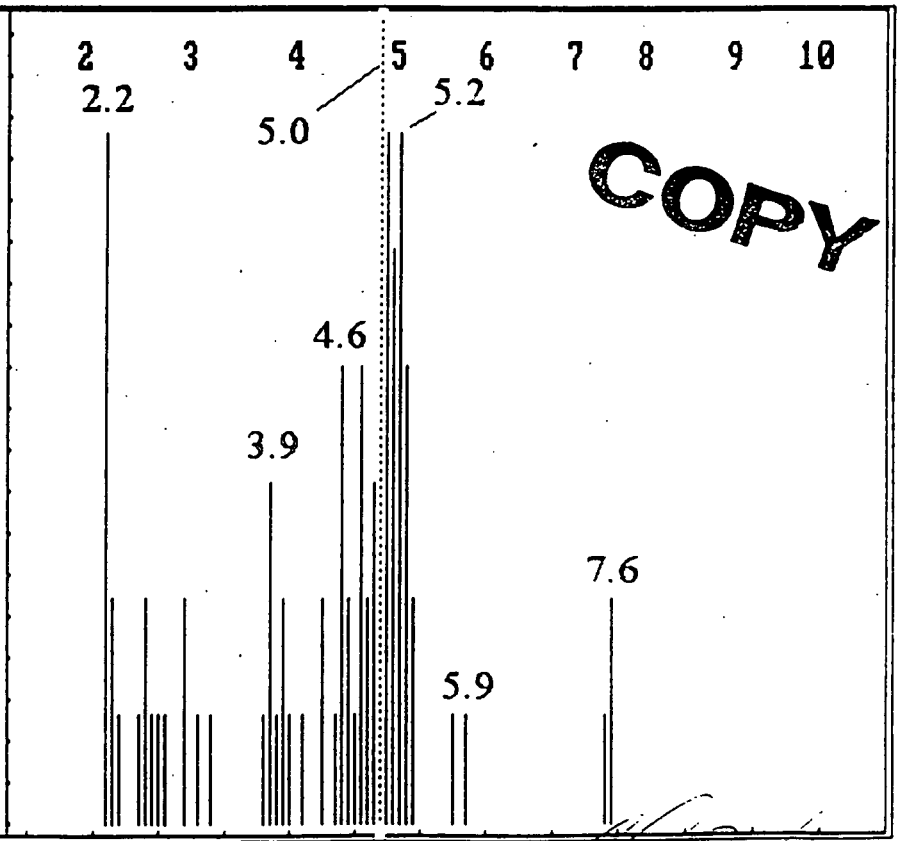
990721.SPE MEV>
REC# 3 OF 3

MIN: 0
MAX: 7
RANGE: 7
SCALE: MIN to MAX

Cursor MEV: 5.0
COUNT: 7
Pu239 Cts: 44
Radon Cts: 4
Gross Cts: 82
Count time: 69 min

AP-2 SN# A146

Item Description: Metal Roof T112B
Location# 1



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Date Reviewed: 8/6/99 RS Supervision: S Eastbrook / [signature] [redacted]
Print Name Signature

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Radioanalytical Results

Report Identification Number: 99A8967

Project Name: Kaiser-Hill Chain-of-Custody Number: 99A89678002 Matrix: Waste
Site Sample ID: 003.002
Other Sample ID: T112 B NW CORNER Collection Date: 7/21/99 Date Received: 7/27/99
Batch Number: 1643 Laboratory Code: SCA

Method Number	Radionuclide	Laboratory Sample ID	Activity (pCi/g)	2 σ Counting Error (pCi/g)	Total Error (pCi/g)	MDA (pCi/g)
ACW03	U-233/234	KH199-1643-03	0.030	0.049	0.050	0.076
ACW03	U-235	KH199-1643-03	0.000	0.000	0.000	0.045
ACW03	U-238	KH199-1643-03	0.035	0.048	0.048	0.064
ACW03	PU-239/240	KH199-1643-03	0.022	0.044	0.044	0.059
ACW03	AM-241	KH199-1643-03B	2.37	0.740	0.879	0.119

Quality Control Samples			
Radionuclide	Laboratory Control Sample (LC)	Laboratory Duplicate Analysis (LD)	Preparation Blank (PB)
U	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB
Pu	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB
Am	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB

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Radioanalytical Results

Report Identification Number: 99A8967

Project Name:	Kaiser-Hill	Chain-of-Custody Number:	99A89679002	Matrix:	Waste
Site Sample ID:	004.002				
Other Sample ID:	T112 B NE CORNER	Collection Date:	7/21/99	Date Received:	7/27/99
		Batch Number:	1643	Laboratory Code:	SCA

Method Number	Radionuclide	Laboratory Sample ID	Activity (pCi/g)	2 σ Counting Error (pCi/g)	Total Error (pCi/g)	MDA (pCi/g)
ACW03	U-233/234	KH199-1643-04	0.068	0.061	0.062	0.037
ACW03	U-235	KH199-1643-04	0.017	0.033	0.034	0.045
ACW03	U-238	KH199-1643-04	0.013	0.027	0.027	0.037
ACW03	PU-239/240	KH199-1643-04	-0.010	0.020	0.020	0.117
ACW03	AM-241	KH199-1643-04B	0.000	0.000	0.000	0.088

Quality Control Samples			
Radionuclide	Laboratory Control Sample (LC)	Laboratory Duplicate Analysis (LD)	Preparation Blank (PB)
U	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB
Pu	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB
Am	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB

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Radioanalytical Results

RECOUNT

Report Identification Number: 99A6967

Project Name: Kaiser-Hill Chain-of-Custody Number: 99A69678002 Matrix: Waste
Site Sample ID: 005.002
Other Sample ID: T112 B NW CORNER Collection Date: 7/21/99 Date Received: 7/27/99
Batch Number: 1643 Laboratory Code: SCA

Method Number	Radionuclide	Laboratory Sample ID	Activity (pCi/g)	2 σ Counting Error (pCi/g)	Total Error (pCi/g)	MDA (pCi/g)
ACW03	U-233/234	KH199-1643-05	0.050	0.057	0.058	0.068
ACW03	U-235	KH199-1643-05	0.000	0.000	0.000	0.046
ACW03	U-238	KH199-1643-05	0.055	0.055	0.057	0.037
ACW03	PU-239/240	KH199-1643-05	-0.004	0.045	0.045	0.117
ACW03	AM-241	KH199-1643-05	2.53	0.771	0.922	0.389

Quality Control Samples

Radionuclide	Laboratory Control Sample (LC)	Laboratory Duplicate Analysis (LD)	Preparation Blank (PB)
U	SCAQC-1643-LC1B	SCAQC-1643-LD1B	SCAQC-1643-PBB
Pu	SCAQC-1643-LC1B	SCAQC-1643-LD1B	SCAQC-1643-PBB
Am	SCAQC-1643-LC1B	SCAQC-1643-LD1B	SCAQC-1643-PBB

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Radioanalytical Results

RE-COUNT #2

Report Identification Number: 99A8967

Project Name:	Kaiser-Hill	Chain-of-Custody Number:	99A8967#002	Matrix:	Waste
Site Sample ID:	008.002				
Other Sample ID:	T112 B NW CORNER	Collection Date:	7/21/99	Date Received:	7/27/99
		Batch Number:	1643	Laboratory Code:	SCA

Method Number	Radionuclide	Laboratory Sample ID	Activity (pCi/g)	2 σ Counting Error (pCi/g)	Total Error (pCi/g)	MDA (pCi/g)
ACW03	U-233/234	KH199-1643-06	0.063	0.072	0.073	0.084
ACW03	U-235	KH199-1643-06	0.065	0.075	0.076	0.059
ACW03	U-238	KH199-1643-06	0.063	0.072	0.073	0.084
ACW03	PU-239/240	KH199-1643-06	0.015	0.059	0.059	0.118
ACW03	AM-241	KH199-1643-06	1.80	0.598	0.698	0.106

Quality Control Samples			
Radionuclide	Laboratory Control Sample (LC)	Laboratory Duplicate Analysis (LD)	Preparation Blank (PB)
U	SCAQC-1643-LC1C	SCAQC-1643-LD1C	SCAQC-1643-PBC
Pu	SCAQC-1643-LC1C	SCAQC-1643-LD1C	SCAQC-1643-PBC
Am	SCAQC-1643-LC1C	SCAQC-1643-LD1C	SCAQC-1643-PBC

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Radioanalytical Results REANALYSIS #1

Report Identification Number: 99A8967

Project Name: Kaiser-Hill		Chain-of-Custody Number: 99A8967#002		Matrix: Waste	
Site Sample ID: 007-002					
Other Sample ID: T112 B NW CORNER		Collection Date: 7/21/99		Date Received: 7/27/99	
		Batch Number: 1643		Laboratory Code: SCA	

Method Number	Radionuclide	Laboratory Sample ID	Activity (pCi/g)	2 σ Counting Error (pCi/g)	Total Error (pCi/g)	MDA (pCi/g)
ACW03	U-233/234	KH199-1643-07	0.173	0.132	0.136	0.067
ACW03	U-235	KH199-1643-07	0.000	0.000	0.000	0.082
ACW03	U-238	KH199-1643-07	0.088	0.100	0.102	0.118
ACW03	PU-239/240	KH199-1643-07	0.000	0.000	0.000	0.094
ACW03	AM-241	KH199-1643-07	0.000	0.000	0.000	0.272

Quality Control Samples			
Radionuclide	Laboratory Control Sample (LC)	Laboratory Duplicate Analysis (LD)	Preparation Blank (PB)
U	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB
Pu	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB
Am	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB

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30

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Radioanalytical Results REANALYSIS #2

Report Identification Number: 99A8967

Project Name: Kaiser-Hill	Chain-of-Custody Number: 99A8967#002		Matrix: Waste
Site Sample ID: 008-002			
Other Sample ID: T112 B NW CORNER	Collection Date: 7/21/99	Date Received: 7/27/99	
	Batch Number: 1643	Laboratory Code: SCA	

Method Number	Radionuclide	Laboratory Sample ID	Activity (pCi/g)	2 σ Counting Error (pCi/g)	Total Error (pCi/g)	MDA (pCi/g)
ACW03	U-233/234	KH199-1643-08	0.288	0.182	0.191	0.145
ACW03	U-235	KH199-1643-08	-0.013	0.025	0.026	0.152
ACW03	U-238	KH199-1643-08	0.118	0.117	0.119	0.122
ACW03	PU-239/240	KH199-1643-08	0.033	0.066	0.066	0.069
ACW03	AM-241	KH199-1643-08	0.036	0.073	0.073	0.096

Quality Control Samples			
Radionuclide	Laboratory Control Sample (LC)	Laboratory Duplicate Analysis (LD)	Preparation Blank (PB)
U	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB
Pu	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB
Am	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB

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Radioanalytical Results

Quality Control Sample
Preparation Blank (PB)

Report Identification Number: 99A8967

Project Name: Kaiser-Hill | Chain-of-Custody Number: None | Matrix: Water
Site Sample ID: N/A
Other Sample ID: PB | Collection Date: 7/27/99 | Date Received: 7/27/99
Laboratory Code: SCA

Method Number	Radionuclide	Laboratory Sample ID	Activity (dpm)	2 σ Counting Error (dpm)	Total Error (dpm)	MDA (dpm)
ACW03	U-233/234	SCAQC-1643-PB	0.043	0.049	0.050	0.039
ACW03	U-235	SCAQC-1643-PB	0.000	0.000	0.000	0.048
ACW03	U-238	SCAQC-1643-PB	0.079	0.071	0.072	0.068
ACW03	PU-239/240	SCAQC-1643-PB	0.000	0.000	0.000	0.056
ACW03	AM-241	SCAQC-1643-PB	0.000	0.000	0.000	0.053

	Quality Control Samples		
Radionuclide	Laboratory Control Sample (LC)	Laboratory Duplicate Analysis (LD)	Preparation Blank (PB)
U	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB
Pu	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB
Am	SCAQC-1643-LC1	SCAQC-1643-LD1	SCAQC-1643-PB

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Radioanalytical Results

Quality Control Sample Evaluation

Report Identification Number: 99A8967

Project Name: Kaiser-Hill Laboratory Code: SCA

Laboratory Contol Sample (LC1) Evaluation

Method Number	Radionuclide	Laboratory Sample ID	(CV) Decay Corrected Activity of Spike Added (dpm)	(OV) Laboratory Control Sample Activity (dpm)	Laboratory Control Sample % Recovery (Accuracy)	Number of σ Between CV and OV
ACW03	AM-241	SCAQC-1643-LC1	4.24 ∓ 0.117	4.38 ∓ 1.17	103	0.191
ACW03	PU-239/240	SCAQC-1643-LC1	4.55 ∓ 0.100	5.13 ∓ 1.37	113	0.673
ACW03	U-233/234	SCAQC-1643-LC1	8.02 ∓ 0.321	7.25 ∓ 1.75	90.3	0.660
ACW03	U-238	SCAQC-1643-LC1	8.02 ∓ 0.321	7.74 ∓ 1.86	96.4	0.231

Laboratory Duplicate Sample (LD1) Evaluation

Method Number	Radionuclide	Laboratory Sample ID	Original Sample Activity (pCi/g)	Duplicate Sample Activity (pCi/g)	Difference Between Original Activity and Duplicate Sample Activity (F)	Ratio of the Difference Between the Sample Activities and the Propegated Measurement Original Activity and Uncertainty of the Difference at 2 σ (F/E)
ACW03	U-233/234	SCAQC-1643-LD1	0.264 ∓ 0.129	0.244 ∓ 0.133	0.020	0.108
ACW03	U-235	SCAQC-1643-LD1	0.016 ∓ 0.031	0.018 ∓ 0.037	0.003	0.055
ACW03	U-238	SCAQC-1643-LD1	0.270 ∓ 0.132	0.170 ∓ 0.109	0.100	0.567
ACW03	PU-239/240	SCAQC-1643-LD1	0.000 ∓ 0.000	0.041 ∓ 0.059	0.041	0.696
ACW03	AM-241	SCAQC-1643-LD1	0.000 ∓ 0.000	0.054 ∓ 0.078	0.054	0.696