Health Physics Manual

Kaiser Aluminum & Chemical Corporation
Thorium Remediation Project
Tulsa, Oklahoma

4000:PA4072
March 2004

Prepared By:

Penn E&R
Environmental & Remediation, Inc.

Penn Environmental & Remediation, Inc.
359 Northgate Drive, Suite 400
Warrendale, PA 15086

Health Physics Manual
Survey Activities Designed
Based on MARSSIM Guidance

Health Physics Manual
Survey Activities Designed
Based on MARSSIM Guidance

Penn E&R
Environmental & Remediation, Inc.
359 North Gate Drive
Suite 400
Warrendale, PA 15086
724/934/3530

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Health Physics Manual
Survey Activities Designed Based on MARISSM Guidance

Table of Contents

Chapter 1.	**General Practices**	
	Penn E&R/HPM/M-1-1	Procedures
	Penn E&R/HPM/M-1-2	Changes to Procedures
	Penn E&R/HPM/M-1-3	Completion of Forms
Chapter 2.	**Instrumentation**	
	Penn E&R/HPM/M-2-1	Basic Instrument Operation
	Penn E&R/HPM/M-2-2	Instrument Minimum Detection Concentration Calculation
	Penn E&R/HPM/M-2-5	Ludlum Model 19 μR Meter
	Penn E&R/HPM/M-2-6	Ludlum Model 2221 Portable Scaler Ratemeter with 44-10 Probe
	Penn E&R/HPM/M-2-7	Ludlum Model 2929 Dual Scaler
	Penn E&R/HPM/M-2-8	Ludlum Model 2360 Scaler/Ratemeter with the Model 43-68 Gas Proportional Detector
Chapter 3.	**Surveys**	
	Penn E&R/HPM/M-3-1	Gross Gamma Surveys
	Penn E&R/HPM/M-3-2	Beta/Gamma Surveys
	Penn E&R/HPM/M-3-3	Alpha Surveys
	Penn E&R/HPM/M-3-4	Exposure Rate Surveys
	Penn E&R/HPM/M-3-5	Removable Alpha and Beta/Gamma Contamination Surveys
	Penn E&R/HPM/M-3-6	Gross Gamma Surveys of Soil Cores
Chapter 4.	**Sampling**	
	Penn E&R/HPM/M-4-1	Surface Soil Sampling
	Penn E&R/HPM/M-4-4	Subsurface Soil Sampling
Chapter 5.	**Quality Assurance**	
	Penn E&R/HPM/M-5-2	Check Source Accountability
Chapter 6.	**Chain of Custody**	
	Penn E&R/HPM/M-6-1	Chain-of-Custody Procedures

PROCEDURE: Penn E&R/HPM/M-1-1

Procedures
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-1-1

Procedures

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/ 934/3530

Procedure: **Penn E&R/HPM/M-1-1**

Title: **Procedures**

1.0 PURPOSE

The purpose of this procedure is to provide a written reference on the organization of the Health Physics Manual.

2.0 DEFINITIONS

NA

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

NA

4.0 EQUIPMENT

NA

5.0 PROCEDURE

Procedures are broken down into categories and are presented in this manual as chapters. These are:

- Chapter 1 – General Practices
- Chapter 2 – Instrumentation
- Chapter 3 – Surveys
- Chapter 4 – Sampling
- Chapter 5 – Quality Assurance
- Chapter 6 – Chain of Custody

6.0 REFERENCES

NA

7.0 ATTACHMENTS

NA

PROCEDURE: Penn E&R/HPM/M-1-2

Changes to Procedures
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-1-2

Changes to Procedures

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

1.0 PURPOSE

The purpose of this procedure is to provide written guidelines for revising existing procedures prior to implementing these changes.

2.0 DEFINITIONS

NA

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS/RESPONSIBILITIES

3.1 Vice President – Radiological Services or his designee is responsible to review and approve proposed field changes, when appropriate.

3.2 Site personnel are responsible to request a field change and receive authorization for such changes prior to implementation of the changes, when appropriate.

4.0 EQUIPMENT

NA

5.0 PROCEDURE

5.1 Major Field Changes

5.1.1 A major field change has the potential to affect one or more of the following:

1. Adversely affect the quality of the data.
2. Adversely affect the consistency of the data.
3. Cause significant change in the cost of the field effort.
4. Create a major change in the scope of the field effort.
5. Cause significant delays in the schedule of the field effort.

5.1.2 Organizations that originally reviewed and approved the procedure will review and approve the major field changes.

5.2 Minor Field Changes

5.2.1 A minor field change is one which does not do one or more of the following:

1. Not adversely affect the quality of the data in the field.
2. Not affect the rationale for field procedures or sampling locations.

5.2.2 Organizations that originally reviewed and approved the procedure will review and approve the minor field changes.

5.2.3 The only exception to the requirements of Substeps 5.2.2 and 5.2.3 is a minor change to a document, such as inconsequential editorial corrections. These corrections will not require review and approval.

5.2.4 Field Change Requests will be maintained as part of the project files.

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

6.0 REFERENCES

NA

7.0 ATTACHMENTS

NA

PROCEDURE: Penn E&R/HPM/M-1-3

Completion of Forms
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-1-3

Completion of Forms

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-05

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

1.0 PURPOSE

The purpose of this procedure is to provide instruction on the proper completion of forms, including survey and instrumentation forms, that are required for the project.

2.0 DEFINITIONS

Form Field: A space on a form where information is to be entered.

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Additional guidance on performing surveys, taking samples, or instrument use can be found in the appropriate Health Physics Manual procedure.

3.2 The forms used to record data are generic, i.e., designed for recording data from various instruments. Record "N/A" in any fields that are not applicable to the instrument.

4.0 EQUIPMENT

4.1 Appropriate form(s) for the work being performed.

4.2 Black pen.

5.0 PROCEDURE

5.1 General Information

5.1.1 Information should be entered in the appropriate manner and in the appropriate form field.

5.1.2 Information should be entered using a black ink pen.

5.1.3 A form field where information is not available or not applicable should be filled with "N/A."

5.1.4 An entire column with repeating information may be filled with a line from top to bottom. The line should begin immediately below a completed form field with the proper information and have definitive markings where the information ceases to apply. The next form field should be properly filled with new information.

5.2 Dates and Times

5.2.1 Dates should be entered in a format that clearly identifies the day, month, and year (e.g., 1/1/02; 01/01/2002; Jan 1, 2002).

5.2.2 Times should be entered in a format the clearly identifies the hour and minutes (e.g., 8:00 a.m.; 0800; 1:30 p.m.; 1330).

5.3 Signatures, Personnel, and Contact Information

5.3.1 Signature lines should be filled legibly. Include a printed name where necessary.

5.3.2 Initials may be used in a form field if the full name appears elsewhere on the form.

5.3.3 Contact information should include a full name, address, zip code, and telephone number with area code.

5.4 Abbreviations

5.4.1 The use of nonstandard abbreviations should be avoided unless the full wording appears elsewhere on the form and it clearly identifies the abbreviation to be used.

5.5 Result Form Fields

5.5.1 Result form fields should be completed utilizing units that are specified on the form. Form fields that identify units are to be filled clearly utilizing standard notation for the information requested.

5.6 Form Attachments

5.6.1 Attachments to forms should be appropriately labeled to indicate the specific form they accompany.

5.6.2 The accompanying form should clearly reference the attachment (e.g., see Attachment A).

5.7 Corrections

5.7.1 Corrections to form fields shall be made by entering the correct information next to the proper form field and placing a single line through the incorrect entry along with the initials of the person making the correction and the date of correction.

6.0 REFERENCES

NA

7.0 ATTACHMENTS

NA

Chapter 2

Instrumentation

PROCEDURE: Penn E&R/HPM/M-2-1

Basic Instrument Operation
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-2-1

Basic Instrument Operation

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-16-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

1.0 PURPOSE

The purpose of this procedure is to provide instruction on the basic operation of radiological survey instruments.

2.0 DEFINITIONS

Calibration source: A National Institute of Standards and Technology- (NIST) traceable source of a known value used to calibrate an *instrument.*

Check source: A radiological source, not necessarily traceable, which is used to confirm the continuing satisfactory operation of an instrument.

Detector: The portion of an *instrument* that transmits a signal to a *meter* based upon the radioactive activity present. Some detectors are contained within a *meter.*

Instrument: A meter-detector combination that has been calibrated as a single unit. Some instruments are capable of being calibrated with several detectors simultaneously.

Meter: The portion of an *instrument* that receives and translates signals from the *detector* into a user observable result.

Efficiency: A measure of the instrument's ability to detect radiological activity. It is calculated by using the formula:

$$E_i = ((C-B_r)/D)$$

Where:

E_i = Instrument efficiency
C = Displayed value from the instrument count of the calibration source (count rate)
B_r = Background count rate
D = Known decay-corrected disintegrations per minute (dpm) value of the calibration source usually between 50,000 to 150,000 dpm . This value is geometry dependent and should be noted on the calibration certificate, e.g., 2π or 4π geometry. For final status or characterization surveys where total alpha or beta scanning or static measurements are performed, obtain a source certificate indicating the 2π (beta or alpha) emission rate to determine instrument efficiency. The product of the instrument efficiency (E_i) and source efficiency are required to calculate the total detector efficiency (E_t). (Note that for gamma detection, the value of D may be provided in different units, e.g., μR/hr.)

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Any person operating a radiological survey instrument must be trained in its use or supervised during its operation by a qualified instructor.

3.2 Failure of any preoperational check will result in the instrument being removed from operation and repaired as necessary.

3.3 An operator repair such as replacing batteries or cables does not require the instrument to be recalibrated. However, the efficiency of the instrument should be recalculated.

3.4 Manufacturer's recommendations regarding use, calibration, and/or maintenance of an instrument will be followed unless otherwise documented in this or other written procedure(s).

3.5 Additional guidance for operating an instrument can be found in the appropriate procedure and/or the manufacturer's manual for that instrument.

3.7 The forms used to record instrument daily check data are generic, i.e., designed for recording information from various instruments. Record "N/A" in any fields that are not applicable to the instrument check.

4.0 EQUIPMENT

4.1 Appropriate check source(s) or calibration source(s), as necessary.

5.0 PROCEDURE

5.1 Preoperational Checks (All instruments before use)

5.1.1 Verify the calibration is current and applicable to the meter-detector combination.

5.1.2 Verify the instrument is capable of detecting the desired activity (e.g., alpha or beta/gamma detector) and that the instrument range encompasses the expected activity.

5.1.3 Inspect any cables for exposed wires, cracks, loose connectors, etc.

5.1.4 Connect any necessary cables or power cords.

5.1.5 Turn instrument on and perform a battery check or verify that the power is on. Replace batteries (or charge battery as appropriate), if necessary.

5.1.6 Hold the detector in the air away from any potentially contaminated surface. Observe the digital and/or analog output and allow the reading to stabilize. Record the resulting background value on the appropriate form for the instrument being used.

5.1.7 Expose the detector to an appropriate check source and allow the response to stabilize. Verify that the response value is acceptable. Enter the response result on the appropriate form for the instrument being used.

5.1.8 While the detector is exposed to the check source, turn up the volume or turn on the speaker (as appropriate) and check for audible response.

5.2 Establish Performance Check Values (Scaler instruments/postcalibration)

5.2.1 Perform necessary preoperational checks to ensure the instrument is operating properly.

5.2.2 Using a repeatable-count geometry, expose the detector to an appropriate check source for the type of radiation required (e.g., alpha, beta, gamma). Perform a minimum of 20 consecutive 1-minute counts of the check source and record the results and units (e.g., counts per minute [cpm]) on Form HPM/M-2-1-1).

5.2.3 Calculate the average of the consecutive counts (x) using the formula provided on Form HPM/M-2-1-1.

5.2.4 Calculate the standard deviation of the consecutive counts (s) using the formula provided on Form HPM/M-2-1-1.

5.2.5 Calculate the minimum number of source counts required (n) based on 10 percent accuracy at the 95 percent confidence level using the following formula. The values of t corresponding to the degrees of freedom (df) can be looked up in Table 1. Degrees of freedom is equal to the number of counts minus 1 (e.g., if 20 counts were performed the df is equal to 19).

$$n = \left[\frac{t_{95,df} \cdot s_x}{0.1 \cdot \bar{x}}\right]^2$$

5.2.6 If n is less than or equal to 20, proceed to the next step. If n is greater than 20, perform the additional number of counts required (i.e., n –20) and return to Substep 5.2.3.

5.2.7 Calculate the acceptance criteria for daily source checks by adding and subtracting three standard deviations. For trend analysis, add and subtract two standard deviations from the average. Record the results on Form HPM/M-2-1-1.

5.2.8 Repeat Section 5.2 each time the instrument is recalibrated.

5.3 Establish Performance Check Values (Ratemeter instruments)

5.3.1 Perform all necessary preoperational checks to ensure the instrument is operating properly.

5.3.2 Using a repeatable-count geometry expose the detector to an appropriate check source for the type of radiation required (e.g., alpha, beta, gamma). When the reading stabilizes, record the result. Perform a minimum of 10 consecutive counts of the check source and record the results and units (e.g., cpm, on Form HPM/M-2-1-1).

5.3.3 Calculate the average of the consecutive counts (x) using the formula provided on Form HPM/M-2-1-1.

5.3.4 Calculate the standard deviation of the consecutive counts (s) using the formula provided on Form HPM/M-2-1-1.

5.3.5 Calculate the minimum number of source counts required (n) based on 20 percent accuracy at the 95 percent confidence level using the following formula. The values of t corresponding to the df can be looked up in Table 1. Degrees of freedom is equal to the number of counts minus 1 (e.g., if 10 counts were performed the df is equal to 9).

$$n = \left[\frac{t_{95,df} \cdot s_x}{0.2 \cdot \bar{x}} \right]^2$$

5.3.6 If n is less than or equal to 10, proceed to the next step. If n is greater than 10, perform the additional number of counts required (i.e., n –10) and return to Substep 5.3.3.

5.3.7 Calculate the acceptance criteria for daily source checks by adding and subtracting 20 percent of the average from the average. Record the results on Form HPM/M-2-1-1.

5.3.8 Repeat Section 5.3 each time the instrument is recalibrated.

Table 1
t-Values

df	t-Value 95%	t-Value 97.5%		df	t-Value 95%	t-Value 97.5%
1	6.314	12.706		36	1.689	2.029
2	2.920	4.303		37	1.688	2.027
3	2.353	3.182		38	1.687	2.025
4	2.132	2.776		39	1.685	2.023
5	2.015	2.571		40	1.684	2.021
6	1.943	2.447		41	1.683	2.020
7	1.895	2.365		42	1.683	2.019
8	1.860	2.306		43	1.682	2.018
9	1.833	2.262		44	1.681	2.017
10	1.812	2.228		45	1.681	2.016
11	1.796	2.201		46	1.680	2.015
12	1.782	2.179		47	1.679	2.014
13	1.771	2.160		48	1.679	2.013
14	1.761	2.145		49	1.678	2.012
15	1.753	2.131		50	1.677	2.010
16	1.746	2.120		51	1.677	2.009
17	1.740	2.110		52	1.676	2.008
18	1.734	2.101		53	1.676	2.007
19	1.729	2.093		54	1.675	2.006
20	1.725	2.086		55	1.674	2.005
21	1.721	2.080		56	1.674	2.004
22	1.717	2.074		57	1.673	2.003
23	1.714	2.069		58	1.672	2.002
24	1.711	2.064		59	1.672	2.001
25	1.708	2.060		60	1.671	2.000
26	1.706	2.056		120	1.658	1.980
27	1.703	2.052		140	1.649	1.966
28	1.701	2.048		∞	1.645	1.960
29	1.699	2.045				
30	1.697	2.042				
31	1.696	2.040				
32	1.694	2.038				
33	1.693	2.036				
34	1.692	2.034				
35	1.690	2.031				

6.0 REFERENCES

6.1 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG/CR-1575, August 2000, Rev. 1.

7.0 ATTACHMENTS

7.1 Forms

Form HPM/M-2-1-1 Performance Check Values

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM/M-2-1-1
Performance Check Values

Project Number:		Project Name:	
Instrument Model:		Technician:	
Instrument S/N:		Date:	
Calibration Due:		Detector Model:	
Radiation Detected:		Detector S/N:	
Source Isotope & S/N:		Detector Type:	
Bkg Count Rate:			

Data Point	Gross Count	Net Count	Data Point	Gross Count	Net Count
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

Average Net Count:		
Standard Deviation of Net Count (Scalers):		
20% of Net Count (Ratemeters):		
Average minus 2 X standard deviation (Scalers):		
Average plus 2 X standard deviation (Scalers):		
Average minus 20% (Ratemeters):		
Average plus 20% (Ratemeters):		

Formulas

Where: n = number of counts (20)

$\bar{x}$ = average of counts

x_i = each count result

$$StdDev = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

Comments:

Prepared By:	Date:
Reviewed By:	Date:

PROCEDURE: Penn E&R/HPM/M-2-2

Instrument Minimum Detection Concentration Calculation

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R /HPM/M-2-2

Instrument Minimum Detection Concentration Calculation

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 200
Warrendale, PA 15086
724/934/3530

1.0 PURPOSE

The purpose of this procedure is to provide instruction on the calculation of the Minimum Detectable Concentration (MDC) value of a radiation detection instrument/detector as required for survey activities. Instruction for the calculation of the sample count time (t_s) required to achieve the MDC value is also provided.

2.0 DEFINITIONS

Calibration source: A National Institute of Standards and Technology- (NIST) traceable check source of a known value used to calibrate or verify the response efficiency of an *instrument.*

Detector: The portion of an *instrument* that transmits a signal to a *meter* based upon the radioactive activity present. Some detectors are contained within a *meter.*

Instrument: A meter-detector combination that has been calibrated as a single unit. Some meters are capable of being calibrated with several detectors simultaneously.

Meter: The portion of an *instrument* that receives and translates signals from the *detector* into a user observable result.

Instrument Efficiency: A measure of an instrument's ability to detect radiological activity. It is calculated by using the formula:

$$E_i = ((C-B_r)/D)$$

Where:

E_i = Instrument efficiency
C = Displayed value from the instrument count of the calibration source (count rate)
B_r = Background count rate
D = Known decay-corrected disintegrations per minute (dpm) value of the calibration source usually between 50,000 to 150,000 dpm. This value is geometry dependent and should be noted on the calibration certificate, e.g., 2π or 4π geometry. For final status or characterization surveys where total alpha or beta scanning or static measurements are performed, obtain a source certificate indicating the 2π (beta or alpha) emission rate to determine instrument efficiency. The product of the instrument efficiency (E_i) and source efficiency are required to calculate the total detector efficiency (E_t). For smear counting, only the total activity (dpm) indicated on the source or certificate is used to calculate efficiency. No correction is required for source efficiency when evaluating smears.

Note that, for gamma detection, the value of D may be provided in different units (e.g., μR/hr).

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 The MDC value should be calculated at a minimum each day that the instrument is used.

3.2 The calculation of MDC is background dependent, i.e., is directly proportional to the background measured with the instrument. Therefore, if background is known to change (e.g., the instrument is moved to a new location for use), the background count rate should be re-determined and the MDC value recalculated.

3.3 For static (fixed-count time) measurements, the MDC value is count-time dependent. The MDC value corresponding to each count time used should be calculated.

3.4 When the calculated MDC value for a static measurement is calculated always ensure that the MDC value is adequate for the survey (e.g., the MDC value is a fraction of the acceptance criteria). If the MDC value is not adequate for the survey, increase the background count time and/or the sample count time and recalculate the MDC value.

4.0 EQUIPMENT

4.1 Calculator or spreadsheet.

5.0 PROCEDURE

5.1 Determination of Counting Times and Minimum Detectable Concentrations

Minimum counting times for background determinations and counting times for measurement of total and removable contamination will be chosen to provide a MDC that meets the acceptance criteria required by the site specific survey plan or other technical basis documents. The Multi-Agency Radiation Survey and Site Investigation Manual's (MARISSM) equations have been modified to convert to units of disintegrations per minute (dpm)/100 square centimeters (cm^2). Count times and scanning rates are determined using the following equations:

5.1.1 Static Counting of Alpha or Beta/Gamma Radiation

Static counting MDC at a 95 percent confidence level is calculated using the following equation, which is an expansion of NUREG 1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, Equation 6-7 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E_{tot} \cdot \frac{A}{100}}$$

Where:

MDC_{static} = minimum detectable concentration level in dpm/100 cm^2
B_R = background count rate in counts per minute
t_B = background count time in minutes
t_S = sample count time in minutes
A = detector probe physical (active) area in cm^2

E_{tot} = total detector efficiency for radionuclide emission of
= E_I x E_s , Where:

E_i = instrument efficiency in counts per disintegration (cpd) based on the source 2π emission rate

E_s = source (or surface contamination) efficiency

Note: Es values can be determined or the default values provided in NUREG-1507 can be used as follows: 0.25 for all alpha energies and beta maximum energies between 0.15 and 0.4 MeV, 0.5 for all beta maximum energies greater than 0.4 MeV.

5.1.2 Beta Ratemeter Scanning

Beta scanning MDC at a 95 percent confidence level is calculated using the following equation which is a combination of MARSSIM Equations 6-8, 6-9, and 6-10:

$$MDC_{scan} = \frac{d'\sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p}\cdot E_{tot}\cdot\frac{A}{100cm^2}}$$

Where:

MDC_{scan} = minimum detectable concentration level in dpm/100 cm^2

d' = desired performance variable (usually 1.38 corresponding to alpha and beta errors of 0.05)

b_i = background counts during the residence interval

i = residence interval in seconds

ρ = surveyor efficiency (0.5 – 0.75, 0.5 is conservative)

A = detector probe physical (active) area in cm^2

E_{tot} = total detector efficiency for radionuclide emission of
= E_i x E_s , Where:

E_i = instrument efficiency in cpd based on the source 2π emission rate

E_s = source (or surface contamination) efficiency

Note: Es values can be determined or the default values provided in NUREG-1507 can be used as follows: 0.25 for all alpha energies and beta maximum energies between 0.15 and 0.4 MeV, 0.5 for all beta maximum energies greater than 0.4 MeV.

5.1.3 Alpha Ratemeter Scanning

Penn E&R
359 North Gate Drive Suite 200
Warrendale, PA 15086
724/934/3530

There are two equations used to determine the alpha scanning Derived Concentration Guideline Values depending on the background level:

For a background level of <3 cpm, the probability of detecting a single count while passing over the contaminated area is:

$$P(n \geq 1) = 1 - e^{\frac{-GE_{tot}d}{60v}}$$

Where:

$P(n \geq 1)$ = probability of observing a single count
G = activity (dpm)
E_{tot} = total detector efficiency for radionuclide emission (E_i x E_s)
d = width of detector in direction of scan (cm)
v = scan speed (cm/s)

Increase the value of G until the corresponding probability equals the desired confidence level (e.g., 95 percent).

Once a count is detected while scanning, stop and hold the detector over the area long enough so that there is 90-percent probability of getting another count as calculated by:

$$t = 13{,}800/CAE$$

Where:

t = time period for static count (s)
C = contamination guideline (dpm)
A = physical probe area (cm^2)
E = total efficiency

For a background level of 3 cpm to about 10 cpm, the probability of detecting two or more counts while passing over the contaminated area is:

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE + B)t}{60}\right)\left(e^{\frac{(GE+B)t}{60}}\right)$$

Where:

$P(n \geq 2)$ = probability of observing two or more counts during t
G = activity (dpm)
E_{tot} = total detector efficiency for radionuclide emission ($E_i \times E_s$)
B = background count rate (cpm)
t = time interval (seconds) over source (d/v)
d =detector width (cm)
v =scan speed (cm/s)

Increase the value of G until the corresponding probability equals the desired confidence level (e.g., 95 percent). If two counts are detected within time interval (t) or (d/v), stop and make a static measurement.

5.1.4 Gamma Soil Scanning

Gamma soil scanning MDCs are calculated for scanning instruments using the method provided in MARSSIM for calculating MDC that controls both Type I and Type II errors (i.e., elimination of false negatives and false positives), as follows:

$$\text{Scan MDC}_{\text{surveyor}} = \frac{d'\sqrt{b_i}(60/i)}{\sqrt{p}\,\epsilon_i}$$

Where: Scan $MDC_{surveyor}$ is the MDC in uR/hr, and

ϵ_i = instrument efficiency in cpm/μR/hour, radionuclide specific, see table below

ρ = surveyor efficiency. Based on laboratory studies documented in References 6 and 7, the value of ρ has been estimated to be between 0.5 and 0.75. The value of 0.5 is conservative

d' = is the value selected from MARSSIM Table 6.5 based on the required true positive and false positive rates, usually 1.38 corresponding to 5 percent false positives and 40 percent false negatives.

b_i = the number of background counts in the interval i (1 second)

i = the scan time interval usually 1 second

In accordance with MARSSIM, the Scan $MDC_{surveyor}$ can be converted to Scan MDC in volumetric units of picocuries per gram by use of a radionuclide specific conversion factor calculated by use of the code MICROSHIELD. Some of the factors are listed below for 2-inch-by-2-inch sodium iodide detectors.

Radio-nuclide	ϵ_i (cpm/ µR/hr)	CF (pCi/g / µR/h)
Cs-137	900	3.81
Co-60	430	0.97
Am-241	13,000	271
Ra-226*	760	1.41
Th-232*	830	0.99

*In equilibrium with all progeny.

6.0 REFERENCES

6.1 NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), December 1997

6.2 NUREG-1507, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, December 1997

7.0 ATTACHMENTS

7.1 Forms

Form HPM/M-2-2-1	Daily Static MDC and Count Time Calculation
Form HPM/M-2-2-2	Daily Beta Scan MDC Calculation
Form HPM/M-2-2-3	Alpha Scan MDC Calculation
Form HPM/M-2-2-4	Gross Gamma Scan MDC Calculation

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM/M-2-2-1
Daily Static MDC and Count Time Calculation

Instrument Serial Number:	Cal. Due:
Detector Serial Number:	Cal. Due:
Radiation Detected:	

E_i (Instrument Efficiency):	(cpd)
E_s (Source Efficiency):	(-)
E_{tot} (Total Efficiency):	(cpd)
A (Active Probe Area):	(cm^2)

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E_{tot} \cdot \frac{A}{100}}$$

	D date	B background (counts)	t_b background count time (min)	B_r background count rate (cpm)	t_s sample count time (min)	MDC_{static} min. detectable concentration (dpm/100cm^2)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

Comments:	
Prepared By:	Date:
Reviewed By:	Date:

Notes:

1. $E_{tot} = E_i \times E_s$.
2. Source Efficiency (E_s) is also refered to as Contamination Source Efficiency or Surface Efficiency.
3. E_s is equal to 0.25 for all alpha emissions and beta emissions with maximum energy between 0.15 and 0.4 Mev. For maximum beta energies > 0.4 MeV, E_s is equal to 0.5.

Penn ER.
359 North Gate Drive Sutie 400
Warrendale, PA 15086
724/934/3530

Form HPM/M-2-2-2
Daily Beta Scan MDC Calculation

Instrument Serial Number:		Cal. Due:	
Detector Serial Number:		Cal. Due:	
Radiation Detected:	Beta		

E_i (Instrument Efficiency):		(cpd)
E_s (Source Efficiency):		(-)
E_{tot} (Total Efficiency):		(cpd)
A (Active Probe Area):		(cm^2)

$$MDC_{scan} = \frac{d'\sqrt{b_i}\sqrt{(60/i)}}{\sqrt{p}\cdot E_{tot}\cdot\frac{A}{100cm^2}}$$

	D date	b_i background count rate (cpm)	I scan time (seconds)	ρ surveyor E (0.5 - 0.75) (-)	d' MARSSIM Table 6.5 (-)	MDC_{scan} min. detectable concentration (dpm/100cm^2)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						

Comments:	
Prepared By:	Date:
Reviewed By:	Date:

Notes:

1. $E_{tot} = E_i \times E_s$.
2. Source Efficiency (E_s) is also refered to as Contamination Source Efficiency or Surface Efficiency.
3. E_s is equal to 0.25 for all alpha emissions and beta emissions with maximum energy between 0.15 and 0.4 Mev. For maximum beta energies > 0.4 MeV, E_s is equal to 0.5.
4. ρ = surveyor efficiency, ranges from 0.5 to 0.75, 0.5 is conservative.
5. d' = desired performance variable (usually 1.38 corresponding to alpha and beta errors of 0.05).

Penn ER.
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Form HPM/M-2-2-3
Alpha Scan MDC Calculation

Instrument Serial Number:		Cal. Due:	
Detector Serial Number:		Cal. Due:	
Radiation Detected:	Alpha		

Probability of observing 2 or more counts:

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE+B)d}{60v}\right)\left(e^{-\frac{(GE+B)d}{60v}}\right)$$

Probability of observing a single count:

$$P(n \geq 1) = 1 - e^{\frac{-GEd}{60v}}$$

	D date	G Activity (dpm)	d Detector Width (cm)	E Instrument Efficiency (cpm)	v Scan Speed (cm/s)	B Background Countrate (cpm)	P Probability (-)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							

Comments:	
Prepared By:	Date:
Reviewed By:	Date:

Note:
1. Instrument efficiency is the 4p instrument efficiency.

Penn ER
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Form HPM/M-2-2-4
Gross Gamma Scan MDC Calculation

Instrument Serial Number:		Cal. Due:	
Detector Serial Number:		Cal. Due:	
Radiation Detected:	Gamma	Type of Detector:	

$$MDCR = \frac{d' \sqrt{b_i}(60 / i)}{\sqrt{p}}$$

$$\text{Scan MDC}_{\text{surveyor}} = \frac{d' \sqrt{b_i}(60 / i)}{\sqrt{p}\,\epsilon_i}$$

$$\text{Scan MDC} = \frac{d' \sqrt{b_i}(60 / i)}{\sqrt{p}\,\epsilon_i\,CF}$$

D date	Radio-nuclide	b_i background count rate (cpm)	E_i	I scan time (seconds)	r surveyor E (0.5 - 0.75) (-)	d' MARSSIM Table 6.5 (-)	MDCR min. detectable countrate (cpm)	Scan $MDC_{surveyor}$ min. detectable concentration (mR/hr)	CF conversion factor (pCi/g / mR/hr)	Scan MDC min. detectable concentration (pCi/g)

Comments:	
Prepared By:	Date:
Reviewed By:	Date:

Notes:
CF = Conversion factor (Microshield/NUREG-1507).
ncpm = Net counts per minute.
mR/h = microRoentgen per hour.
E_i = Instrument efficiency (from Table 6.7 of MARSSIM).
pCi/g = Picocuries per gram.

PROCEDURE: Penn E&R/HPM/M-2-5

Ludlum Model 19 μR Meter
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R /HPM/M-2-5

Ludlum Model 19 μ R Meter

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Procedure: **Penn E&R/HPM/M-2-5**

Title: **Ludlum Model 19 µR Meter**

1.0 PURPOSE

The purpose of this procedure is to provide basic operational instructions for the Model 19 µR Meter.

2.0 DEFINITIONS

AEPR: Acceptable End Point Range, range of detection displayed on the instrument where the confidence of the meter is not in question. The AERP is generally the center three quarters of the analog meter face.

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Penn E&R/HPM/M-2-1, "Basic Instrument Operation"

4.0 EQUIPMENT

- Ludlum Model 19 µR Meter
- Batteries

5.0 PROCEDURE

5.1 Installing Batteries

5.1.1 Open the lid and install two "D" size batteries. Note (+) (-) marks on the inside of lid. Match the battery polarity to these marks.

NOTE: To open the battery lid, twist the lid button counterclockwise one-quarter turn. To close, twist clockwise one-quarter turn.

5.1.2 Close the battery box lid.

5.2 Preoperational Checks

5.2.1 Adjust the audio (AUD) ON-OFF switch as desired.

5.2.2 Replace the batteries if the meter pointer is below the BAT TEST line. Check the battery by switching the power switch to BATT.

5.2.3 Check the meter response in the "F" and "S" positions.

5.2.4 Check the audio indication with the AUD ON-OFF switch.

5.2.5 Depress the reset (RES) pushbutton. Check to see that the meter pointer returns to the zero position.

5.3 Operational Checks

5.3.1 Prior to using the Ludlum Model 19, the performance check value of the average response will be determined. If the instrument is recalibrated at any point, the performance check values will need to be re-established in accordance with Procedure Penn E&R/HPM/M-2-1.

5.3.2 Each day the instrument is used, determine the ambient background and record on Form HPM/M-2-5-1.

5.3.3 Each day that the Ludlum Model 19 is used, the response will be checked using an appropriate check source as follows:

5.3.3.1 Place the check source on the front lower portion of the meter.

5.3.3.2 Allow for the meter face to stabilize.

5.3.3.3 Ensure that the meter reading is taken within the AEPR for accuracy and reproducibility.

5.3.4 Check the source check result against the established postcalibration acceptance criteria. Failed source checks will be repeated. Consecutive failures will result in additional testing of the instrument. Refer to the instrument manual.

5.3.5 Survey data acquired prior to an instrument failing a source check will be reviewed to determine the validity of the data. This review will be documented.

5.3.6 Record the source check reading on Form HPM/M-2-5-1.

6 REFERENCES

6.1 Instruction Manual - Ludlum Measurements, Inc., Sweetwater, TX, for Model 19 μR Meter, Revised July, 1997 for Serial Number138413 and succeeding serial numbers.

7 ATTACHMENTS

7.1 Forms

Form HPM/M-2-5-1 Daily Check Log for Ludlum Model 19 μR Meter

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM/M-2-5-1
Daily Check Log for Ludlum Model 19 µR Meter

Instrument Model:	19
Instrument S/N:	
Detector Model:	N/A
Detector S/N:	N/A
Calibration Due:	

Source S/N:	
Source DPM:	N/A
Radiation Detected:	Gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	

Date	Background µR/hr	Gross Source µR/hr	Net Source µR/hr	Technician	Comments

Comments:

Prepared By: Date:

Reviewed By: Date:

PROCEDURE: Penn E&R/HPM/M-2-6

Ludlum Model 2221 Portable Scaler Ratemeter with 44 -10 Probe

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-2-6

Ludlum Model 2221 Portable Scaler Ratemeter with 44-10 Probe

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04 4-1-04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Procedure: **Penn E&R/HPM/M-2-6**

Title: **Ludlum Model 2221 Portable Scaler Ratemeter with 44-10 Probe**

1.0 PURPOSE

The purpose of this procedure is to provide basic operational instructions for the Ludlum Model 2221 Portable Scaler Ratemeter when accompanied with a 44-10 Probe.

2.0 DEFINITIONS

NA

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Penn E&R/HPM/M-2-1, "Basic Instrument Operation"

4.0 EQUIPMENT

- 44-10 Probe or Equivalent
- Ludlum Model 2221 Portable Scaler Ratemeter
- Batteries

5.0 PROCEDURE

5.1 Installing Batteries

5.1.1 Unscrew battery door latch.

5.1.2 Install four "D" size batteries in the battery holder. The correct position of the batteries is indicated on the bottom of the battery door.

5.2 Instrument Settings for the 44-10 Probe

5.2.1 For scanning area with the 44-10 Probe, the audio divide on the meter is recommended to be set at 10. However, in areas of elevated activity, it may be necessary to increase the audio divide to 100.

5.2.2 The response switch should be selected for fast (F) response when performing scans of the areas.

5.2.3 The window selection should be in the "out" position.

5.2.4 Dig. Rate is used with performing gamma scans and the scaler mode is used when performing fixed counts.

5.3 Operating the Instrument

5.3.1 Switch the Power ON/OFF switch to the ON position. A random number will first be observed in the display, then 8.8:8.8:8.8. The third displayed number will be the program version.

5.3.2 Press COUNT button. The display should zero. Two colons should appear on the display.

5.3.3 Press HOLD button. The colons should disappear.

5.3.4 Switch Lamp toggle switch to the ON position. LCD display backlighting and two lamps at the bottom on the analog meter should be illuminated.

NOTE: If the Lamp switch is left in the ON position for extended periods of time, battery life will decrease rapidly.

5.3.5 Check the rest of the Test functions for proper operation.

5.4 Preoperational Checks

5.4.1 Ensure that the cables are in good condition. Cables can be checked by gently wriggling the cable and listening for changes to the inflections in the audible response.

5.4.2 Ensure that the connections are in their locked position and in proper contact. This can be checked by gently wriggling the ends of the connections and listening for changes to the inflections in the audible response.

5.4.3 If changes in the audible response are noted, the cable may be damaged. Replace the cable and perform the above steps again.

5.4.4 Depress the BAT button on the meter face. The reading will show up as a number between 1 and 6. It is suggested that the batteries be replaced when the reading falls below 5.2.

5.5 Operational Checks

5.5.1 Prior to using the counting system, the performance check value of the average response will be determined. If the instrument is recalibrated at any point, the performance check value will need to be re-established in accordance with Procedure Penn E&R/HPM/M-2-1.

5.5.2 Each day the instrument is used, determine the ambient background and record on Form HPM/M-2-6-1.

5.5.3 Each day that a counting system is used, the response will be checked using an appropriate check source as follows:

5.5.3.1 The source is placed under the detector and counted for one minute. Ensure the count geometry is consistent with the geometry used to establish acceptance criteria.

5.5.3.2 The net counts per minute value is compared to the performance check value to determine a pass or fail status.

5.5.3.3 Record the result on Form HPM/M-2-6-1.

5.5.4 Failed source checks will be repeated. Consecutive failures will result in additional testing of the instrument. Refer to the meter/detector manuals.

5.5.5 Survey data acquired prior to an instrument failing a source check will be reviewed to determine the validity of the data. This review will be documented.

6.0 REFERENCES

6.1 Instruction Manual - Ludlum Measurements, Inc., Sweetwater, TX, for Ludlum Model 2221 Portable Scaler Ratemeter.

7.0 ATTACHMENTS

7.1 Forms

Form HPM/M-2-6-1 Daily Check Log for Ludlum Model 2221 with 44-10 Detector

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector

Instrument Model:	2221
Instrument S/N:	
Detector Model:	44-10
Detector S/N:	
Calibration Due:	

Source S/N:	
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	

Date	Background Count Rate	Gross Source Count Rate	Net Source Count Rate	Technician	Comments

Comments:

Prepared By: Date:

Reviewed By: Date:

PROCEDURE: Penn E&R/HPM/M-2-7

Ludlum Model 2929 Dual Scaler
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-2-7

Ludlum Model 2929 Dual Scaler

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Procedure: **Penn E&R/HPM/M-2-7**

Title: **Ludlum Model 2929 Dual Scaler**

1.0 PURPOSE

The purpose of this procedure is to provide basic operational instruction for the Ludlum Model 2929 Dual Scaler.

2.0 DEFINITIONS

Background: A measurement taken by an instrument to determine the amount of naturally occurring radiation at a given time at a given location.

Planchet: A tray onto which a *swipe* sample or *smear* is placed in order to be analyzed.

Swipe: A cloth or paper disc that is wiped on the surface of an area or object being surveyed. Also referred to as a *smear.*

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Penn E&R/HPM/M-2-1, "Basic Instrument Operation"

3.2 Penn E&R/HPM/M-2-1, "Instrument Minimum Detectable Concentration Calculations"

4.0 EQUIPMENT

- Ludlum Model 2929 Dual Scaler
- Planchets
- Cloth Swipes

5.0 PROCEDURE

5.1 Preoperational Checks

5.1.1 Turn the instrument on.

5.1.2 Slide sample receiver into the base of the counting instrument and lock down the receiver by turning the locking mechanism clockwise.

5.1.3 Adjust the audible volume so that the alpha and beta/gamma clicks can be easily heard.

5.1.4 Ensure that the cables are in good condition. Cables can be checked by gently wriggling the cable and listening for changes to the inflections in the audible response.

5.1.5 Ensure that the connections are in their locked position and in proper contact. This can be checked by gently wriggling the ends of the connections and listening for changes to the inflections in the audible response.

5.1.6 If changes in the audible response are noted, the cable may be damaged. Replace the cable and perform the above steps again.

5.2 Operational Checks

5.2.1 Prior to using the counting system, the source check acceptance criteria of the average response will be determined. If the instrument is recalibrated at any point, the source check acceptance criteria will need to be re-established, in accordance with Procedure Penn E&R/HPM/M-2-1.

5.2.2 Each day the instrument is used, determine the ambient background and record on Form HPM/M-2-7-1.

5.2.3 Perform the background count for the predetermined duration by completely closing and locking the tray and pressing the count button. At the end of the time, record the results and count time.

5.2.4 Each day that a counting system is used, the response will be checked using an appropriate source, as follows.

5.2.4.1 Perform the source count by placing the appropriate source (alpha or beta) on a planchet. Place the planchet in the tray and insert the tray. Completely close the tray and lock the source into place. Begin the source count by depressing the count button. At the end of the time, record the results. This count is performed on both alpha and beta sources.

5.2.4.2 The net counts per minute value is compared to the acceptance criteria to determine a pass or fail status.

5.2.4.3 Record the source check readings on Form HPM/M-2-7-1.

5.2.4 Compare the source check result against the established postcalibration acceptance criteria. Failed source checks will be repeated. Consecutive failures will result in additional testing of the instrument. Refer to instrument manual.

5.2.5 Survey data acquired prior to an instrument failing a source check will be reviewed to determine the validity of the data. This review will be documented.

5.2.6 Determine the minimum detectable concentration for the instrument each day used, in accordance with Procedure Penn E&R/HPM/M-2-2.

5.3 Counting Samples

5.3.1 Check and set the time indicator for the sample count guidelines.

5.3.2 Place the swipe sample on a planchet. Open the tray and insert the planchet. Completely close the tray and lock it into place. Press the count button.

5.3.3 At the end of the predetermined time period, record the alpha and beta/gamma counts.

5.3.4 Remove the planchet and repeat, as necessary.

5.3.5 A routine background count should be performed periodically between sample measurements to assure that no residual build-up of contamination occurs on sample tray or planchet. A separate planchet is preferable for each sample. Properly decontaminate the sample tray and/or planchet as appropriate.

6.0 REFERENCES

NA

7.0 ATTACHMENTS

Form HPM/M-2-7-1 Daily Check for Ludlum Model 2929 with a 43-10-1 Detector

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM/M-2-7-1
Daily Check Log for Ludlum Model 2929 with a 43-10-1 Detector

Instrument Model:	2929		Source S/N:		
Instrument S/N:			Source Amount		
Detector Model:	43-10-1		Radiation Detected:	Alpha	Beta
Detector S/N:			Acceptable Range:		
Calibration Due:			Background Count Time:		

Date	Background Count Rate Alpha (cpm)	Background Count Rate Beta (cpm)	Gross α Source Count Rate (cpm)	Gross β Source Count Rate (cpm)	Net α Source Count Rate (cpm)	Net β Source Count Rate (cpm)	Technician	Comments

Prepared By:	Date:
Reviewed By:	Date:

PROCEDURE: Penn E&R/HPM/M-2-8

Ludlum Model 2360 Scaler / Ratemeter with the Model 43-68 Gas Proportional Detector

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-2-8

Ludlum Model 2360 Scaler/Ratemeter with the Model 43-68 Gas Proportional Detector

REVISION: 0

EFFECTIVE DATE: MARCH 2004

Prepared by: Date: 3/31/04
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

Approved by: Date: 4-1-04
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Procedure: **Penn E&R/HPM/M-2-8**

Title: **Ludlum Model 2360 Scaler/Ratemeter with the Model 43-68 Gas Proportional Detector**

1.0 PURPOSE

The purpose of this procedure is to provide basic operational instruction for the Ludlum Model 2360 Scaler/Ratemeter with the Model 43-68 Gas Proportional Detector.

2.0 DEFINITIONS

Background: A measurement taken by an instrument to determine the amount of naturally occurring radiation at a given time at a given location.

Calibration source: A National Institute of Standards and Technology- (NIST) traceable check source of a known value used to calibrate or verify the response efficiency of an *instrument.*

Detector: The portion of an *instrument* that transmits a signal to a *meter* based upon the radioactive activity present. Some detectors are contained within a *meter.*

Instrument: A meter-detector combination that has been calibrated as a single unit. Some instruments are capable of being calibrated with several detectors simultaneously.

Meter: The portion of an *instrument* that receives and translates signals from the *detector* into a user observable result.

Efficiency: A measure of the instrument's ability to detect radiological activity. It is calculated by using the formula:

$$E = ((C-B_r)/D)$$

Where:

E = Instrument efficiency
C = Displayed value from the instrument count of the calibration source (count rate)
B_r = Background count rate
D = Known decay-corrected disintegrations per minute (dpm) value of the calibration source usually between 50,000 to 150,000 dpm. This value is geometry dependent and should be noted on the calibration certificate, e.g., 2π or 4π geometry. For final status or characterization surveys where total alpha or beta scanning or static measurements are performed, obtain a source certificate indicating the 2π (beta or alpha) emission rate to determine instrument efficiency. The product of the instrument efficiency (E_i) and source efficiency are required to calculate the total detector efficiency (E_t).

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Any person operating a radiological survey instrument must be trained in its use or supervised during its operation by a qualified instructor.

3.2 Failure of any preoperational check will result in the instrument being removed from operation and repaired as necessary.

3.3 An operator repair such as replacing batteries or cables does not require the instrument to be recalibrated. However, the efficiency of the instrument should be checked.

3.4 All manufacturer's recommendations regarding use, calibration, and/or maintenance of an instrument will be followed unless otherwise documented in this or other written procedure(s).

3.5 Additional guidance for operating an instrument can be found in the appropriate procedure and/or the manufacturer's manual for that instrument.

3.6 Penn E&R/HPM/M-2-1, "Basic Instrument Operation"

3.7 Penn E&R/HPM/M-2-1, "Instrument Minimum Detectable Concentration Calculations"

4.0 EQUIPMENT

- Ludlum Model 2360 Scaler/Ratemeter, or equivalent
- Ludlum Model 43-68 Gas Proportional Detector, or equivalent
- P-10 Gas

5.0 PROCEDURE

5.1 Preoperational Checks

5.1.1 Turn the instrument on and perform a battery check or verify that the power is on. Replace batteries (or charge battery as appropriate) if necessary.

5.1.2 Adjust the audible volume so that the alpha and beta/gamma clicks can be easily heard.

5.2 Operational Checks

5.2.1 Prior to using the counting system, the source check acceptance criteria of the average response will be determined. If the instrument is recalibrated at any point, the source check acceptance criteria will be re-established, in accordance with Procedure Penn E&R/HPM/M-2-1.

5.2.2 The probe can be used as a sealed chamber or as a continuous purge using P-10 gas (10 percent methane and 90 percent argon).

5.2.2.1 Connect the gas purge valve to one of the ports on the probe creating an outlet port. Assuring that all P-10 system valves are in the closed position, connect the inlet valve to the other port. Starting with the valves closest to the cylinder, slowly adjust the gas flow through the regulator and throttle valves to acquire the proper gas flow.

5.2.2.2 Ensure gas flow does not exceed 0.5 liters per minute (lpm) and does not cause detector window to inflate. To use as a sealed chamber, remove the inlet port valve prior to the outlet gas purge valve creating a sealed chamber for the 43-68 gas proportional detector.

5.2.3 Each day the instrument is used, determine ambient background and record on Form HPM/M-2-8-1.

5.2.4 Each day that a counting system is used, the response will be checked using an appropriate source, as follows.

5.2.4.1 Perform the source count by placing the appropriate source (alpha or beta) beneath the detector in a fixed-count geometry. This count is performed on both alpha and beta sources.

5.2.4.2 The net counts per minute value are compared to the acceptance criteria to determine a pass or fail status.

5.2.4.3 Record the source check readings on Form HPM/M-2-8-1.

5.2.5 Check the source results against the established postcalibration acceptance criteria. Failed source checks will be repeated. Consecutive failures will result in trouble-shooting of the instrument. Refer to instrument manual.

5.2.6 Compare the net counts per minute value of the channel(s) of concern (i.e., alpha) and compare to the last reading taken immediately after a purge. If the reading drops greater than 10 percent, the probe must be repurged with P-10 gas for a minimum of 15 minutes. If the probe is being used as a continuous purge, the gas flow rate may be too low. A visual inspection of the mylar window should be made to assure the integrity of the gas chamber.

5.2.7 Survey data acquired prior to an instrument failing a source check will be reviewed to determine the validity of the data. This review will be documented.

5.2.8 Determine the minimum detectable concentration for the instrument each day used, in accordance with Procedure Penn E&R/HPM/M-2-2.

5.3 Gas Decay Check (If Required)

5.3.1 Connect the gas purge valves as necessary.

5.3.2 Turn on gas flow.

5.3.3 Ensure gas flow does not exceed 0.5 liters per minute (lpm) and does not cause detector window to inflate.

5.3.4 Gas purge duration should be at least 15 minutes.

5.3.5 Connect the detector to the appropriate meter.

5.3.6 Initiate a background count in air for the predetermined duration. Record result on Form HPM/M-2-8-1.

5.3.7 Expose the detector to calibration source(s) and initiate a count for the predetermined duration.

5.3.8 Calculate the efficiency response(s) and compare to the efficiency percent value(s) at calibration. The efficiency value(s) should approximate the efficiency value(s) for the calibration source(s) obtained either during or following calibration. Low efficiency value(s) may mean the gas purge duration was not sufficient. In that case, continue the gas purge for at least another 15 minutes and repeat the efficiency check. Record the result(s) on Form HPM/M-1-2-2. Remove the instrument from operation if a satisfactory efficiency value is not obtained after a second purge.

5.3.9 Remove the detector from the gas purge and proceed with surveys. Do not exceed the gas decay duration. The gas decay duration is listed on the detector or will be determined in the field using a watch and source checks at 20-minute intervals.

5.3.10 Upon completion of surveys, or prior to the expiration of the gas decay duration, expose the detector to a calibration source(s) and initiate a count for the predetermined duration.

5.3.11 Calculate the efficiency response(s) and record the result(s) on Form HPM/M-1-2-2. Return efficiency response(s) with a difference greater than 10 percent in all detection channels is unacceptable and predicates a review of collected data or resurvey to ensure accurate survey results. The instrument will also be removed from operation and repaired, as necessary.

5.4 Gas Constant Purge Check (If Required)

5.4.1 Connect all gas fittings.

5.4.2 Turn on the gas flow.

5.4.3 Check to ensure gas flow does not exceed 0.5 lpm and does not cause the detector window to inflate.

5.4.4 Gas purge duration should be at least 15 minutes.

5.4.5 Connect the detector to the appropriate meter.

5.4.6 Initiate a background count in air for the predetermined duration. Record result on Form HPM/M-2-8-1.

5.4.7 Expose the detector to a calibration source(s) and initiate a count for the predetermined duration.

5.4.8 Calculate the efficiency response(s) and compare to the efficiency percent value(s) at calibration. The efficiency value(s) should approximate the efficiency value(s) for the calibration source(s) obtained either during or following calibration. Low efficiency value(s) may mean the gas purge duration was not sufficient. In that case, continue the gas purge for at least another 15 minutes and repeat the efficiency check. Record the result(s) on Form HPM/M-2-8-1. Remove the instrument from operation if a satisfactory efficiency value is not obtained after a second purge.

5.4.9 Proceed with the survey.

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

6.0 REFERENCES

NA

7.0 ATTACHMENTS

Form HPM/M-2-8-1 Gas Decay Log

Penn ER
359 North Gate Drive
Warrendale, Pa 15086
724/935/3530

Form HPM/M-2-8-1
Daily Check Log for Ludlum Model 2360 with 43-68 Detector

Instrument/SN: Ludlum Model 2360	*Check Source(s) Used:* Th-230, S/N Tc-99, S/N	
Detector/SN: Model 43-68 /		If not continuous purge, do not exceed 4 hours without repurging
EFF %: α= % 2π 4π β= % 2π 4π	*source check acceptance criteria* α β	
CALIB. SOURCE USED: Th-230, Tc-99	**Average (NCPM):**	Leak Checks: TH-230 Tc-99
DATE OF CALIB.:	**+2 sigma:**	dpm/swipe:
CALIB. DUE DATE:	**-2 sigma:**	date:
PERFORMED BY:	**+3 sigma:**	Performed By:
	-3 sigma:	

TECHNICIAN'S NAME	ALPHA/ BETA	RESPONSE CHECK	DATE	COMMENTS

Reviewed By: Date:

Chapter 3

Surveys

PROCEDURE: Penn E&R/HPM/M-3-1

Gross Gamma Surveys
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-3-1

Gross Gamma Surveys

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

1.0 PURPOSE

The purpose of this procedure is to provide written instruction for measuring gross gamma activity in soil.

2.0 DEFINITIONS

Site Background Count: A measurement taken by an instrument to determine the amount of naturally occurring radiation at a given time and given location.

Shine: Radiation detected from radioactive material in the vicinity of the area that is being surveyed, in addition to natural background radiation.

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Instrument must pass preoperational and operational checks as outlined in Procedure Penn E&R/HPM/M-2-1 and the appropriate instrument procedure.

3.2 Procure any drawings of the survey area which indicate the facility features and reference locations.

3.3 Background count rates may vary by area and time of day. Background should be established in discrete areas based on variations in the background count rate and should be established at least daily for each such area. Variations in background as the elevation of the measurement changes should be accounted for. For example, shine from surrounding structures may be shielded at a lower elevation but may increase background as elevation increases.

3.4 Before initiating a gross gamma soil survey be sure to record the instrument serial number(s), calibration date(s), date of survey, time of survey, study area and survey unit. Refer to Procedure Penn E&R/HPM/M-1-3 for more specifics

3.5 Additional guidance on performing gross gamma surveys is provided in NUREG-1575.

3.6 Ensure the preoperational and source checks have been completed prior to initiating survey.

3.7 If the gross gamma survey is part of a final status survey, refer to the appropriate final status survey plan for additional guidance.

4.0 EQUIPMENT

4.1 2-inch-by-2-inch sodium iodide scintillator, Ludlum Model 44-10, or equivalent

4.2 Ludlum Model 2221 Ratemeter, or equivalent

5.0 PROCEDURE

5.1 The background count rate (in counts per minute [cpm]) should be established for each discrete area to be surveyed and each time (at least daily) that a survey is performed.

5.2 Background count rate should be established at approximately 1 meter above the surface to be scanned. If shine causes the background count rate at 1 meter above the surface to exceed the count rate at the surface, note on the survey map and/or other survey documentation.

5.3 Record the background established for the survey area, the date and time of the background counts for each area, and the average background count rate (cpm) on Form HPM/M-3-1-1.

5.4 Using the guidance provided in Procedure Penn E&R/HPM/M-2-2, calculate the scan Minimum Detectable Concentration prior to surveying the area.

5.5 Position the detector as close to the surface as reasonable but not greater than 10 centimeters from the surface to be surveyed.

5.6 Slowly pass the detector across the surface at a rate of lateral motion not to exceed 0.5 meters per second.

5.7 Listen for a change in the audible response and watch the analog or digital readout for a change.

5.8 If an increase in the audible count rate is detected, pause and allow the reading to stabilize (approximately15 to 30 seconds) and complete the following:

5.8.1 Perform a station fixed-time count (e.g., 1-minute fixed-time count on contact with the soil).

5.8.2 Subtract background established for the grid from the fixed-count result and record the net.

5.9 Mark any areas of elevated activity using paint, grease pencil, survey flags, or other methods, depending on the survey location. An elevated area is any area that exceeds the $DCGL_w$ scan threshold established by correlation of field measurement (ncpm) and laboratory analysis (pci/gram).

5.10 Continue traversing the survey unit (area) until the required survey coverage is achieved.

5.11 Record the results on Form HPM/M-3-1-1 or on other appropriate survey documentation.

5.12 Attach drawings, pictures, and/or supporting data.

6.0 REFERENCES

6.1 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG/CR-1575, August 2000, Rev. 1.

7.0 ATTACHMENTS

7.1 Forms

HPM/M-3-1-1 Survey Data Log

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM/M-3-1-1
Survey Data Log

Instrument Model:	
Instrument S/N:	
Detector Model:	
Detector S/N:	

Date of Survey:	
Units of Measure:	µR/hr / cpm
Radiation Detected:	β γ
Calibration Due:	

Time	Survey Area	Ambient Bkg. Count Rate On Contact	@ 1 Meter	Scan of the Area Maximum	Minimum	Average	On Contact Measurement	Comments

Technician:

Prepared By:	Date:
Reviewed By:	Date:

PROCEDURE: Penn E&R/HPM/M-3-2

Beta / Gamma Surveys
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-3-2

Beta/Gamma Surveys

REVISION: 00

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

1.0 PURPOSE

The purpose of this procedure is to provide written instructions for measuring the static or scanning levels of beta/gamma radiation on structural surfaces.

2.0 DEFINITIONS

Static Count: A count taken for a specified amount of time in a stationary location.

Standoffs: Spacers used to keep the detector at a specified distance from a surface.

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Surface must free of foreign material.

3.2 Instrument must pass preoperational checks as outlined in Procedure Penn E&R/HPM/M-2-1 and the appropriate instrument procedure before use.

3.3 Additional guidance on performing beta/gamma surveys is provided in NUREG-1575.

3.4 If the beta/gamma survey is part of a final status survey, refer to the appropriate final status survey plan for guidance.

4.0 EQUIPMENT

4.1 Appropriate calibrated survey meter and detector.

5.0 PROCEDURE

5.1 Presurvey

5.1.1 Select scaler mode.

5.1.2 Hold the detector in the air away from any potentially contaminated surfaces and perform a background count for the predetermined duration. Record the result in the appropriate survey documentation (e.g., survey maps, Form HPM/M-3-2-1).

5.2 Static Survey

5.2.1 Prior to performing a static survey, use the guidance provided in Procedure Penn E&R/HPM/M-2-2 to calculate the time required to achieve the desired Minimum Detectable Concentration (MDC) value. The desired MDC value should be a fraction of the acceptance criteria specified in the survey plan or other applicable technical basis document.

5.2.2 Select scaler mode.

5.2.3 Position the detector within one-half inch (1.3 centimeters [cm]) of the surface to be surveyed.

5.2.4 Initiate a static count in accordance with the appropriate instrument procedure for the predetermined time duration.

5.2.5 Record the gross result in the appropriate survey documentation (e.g., survey maps, Form Penn E&R/HPM/M-3-2-1). Go to Step 5.4

5.3 Scan Survey

5.3.1 Prior to performing a beta/gamma scan survey, use the guidance provided in Procedure HPM/M-2-2 to calculate the scan MDC.

5.3.2 Select ratemeter mode.

5.3.3 Position the detector within one-half inch (1.3 cm) of the surface to be surveyed. May be accomplished by use of "standoffs" attached to the bottom of the detector.

5.3.4 Slowly pass the detector across the surface to be surveyed at a rate of lateral motion not to exceed one probe width per second (approximately 10 cm, depending on the detector size).

5.3.5 Due to the delicate nature of the probe face, care must be taken to avoid damage by rough surfaces or sharp objects.

5.3.6 Listen for a change in the audible count rate and observe for changes in the analog/digital reading. The surveyor must be careful to listen for subtle audible count rate increases which will occur before a visual increase in needle deflection or digital readout. The surveyor must hold the probe on this area for at least one second to determine the actual reading.

5.3.7 Outline any areas of elevated activity using paint, grease pencil, survey flags, or other methods, depending on the survey location.

5.3.8 Traverse the survey area at very close intervals. Best results are obtained when the areas under the probe overlap due to the directional dependence of the probe.

5.3.9 Record the gross result in the appropriate survey documentation (e.g., survey maps, Form HPM/M-3-2-1).

5.4 Data Conversion

5.4.1 Calculate the beta\gamma disintegrations per minute (dpm)/100 square cm (cm^2) by using the following equation and record on Penn E&R/HPM/M-3-2-2 or other appropriate documentation.

$$\text{Beta\gamma dpm}/100\ cm^2 = ((c/m - B/m)/E)*(100/A)$$

Where:

c/m = total count rate from instrument in counts per minute
B/m = background count rate (predetermined background radiation level taken from an unaffected area)
A = active surface area of the detector in cm^2
E = for final status or characterization surveys where total alpha or beta scanning or static measurements are performed, obtain a source certificate indicating

the 2π (beta or alpha) emission rate to determine instrument efficiency. The product of the instrument efficiency (E_i) and source efficiency are required to calculate the total detector efficiency (E_t).

Total efficiency in counts per disintegration (cpd) is given by $E_i \times E_s$, Where:

E_i = instrument efficiency in cpd determined using the **2π emission rate of the source** (from the calibration certificate)
E_s = source efficiency, 0.25 for maximum beta energies between 0.15 and 0.4 McV and 0.5 for maximum beta energies >4 McV.

5.4.2 Calculate the 95% confidence level uncertainty (2 sigma uncertainty) in units of dpm/100cm2 using the following equation and record on HPM/M-3-2-2 or other appropriate documentation:

$$95\%\ \text{CL Unc.} = 1.96\frac{\sqrt{(samplecounts/(sampletime^2)) + (bkgcounts/(bkgtime^2))}}{(E_i x E_s x (A/100))}$$

6.0 REFERENCES

6.1 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG/CR-1575, August 2000, Rev. 1.

7.0 ATTACHMENTS

7.1 Forms

HPM/M-3-2-1	Decommissioning Survey Data Form
HPM/M-3-2-2	Survey Data Conversion Form

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Decommissioning Survey Data Form

Form ESC/HPM/M-3-2-1

Survey Number:			Survey Date:			Survey Type:						
Location:						Notes:						
Surveyor(s):												
Grid Coordinates		Survey Point Number	A/B Detector S/N	A/B Survey Instrument Serial Number	Survey Instrument Calibration Date	Alpha Count Rate (CPM)	Beta/Gamma Count Rate (CPM)	Alpha Scan Average (CPM)	Alpha Scan Range (CPM)	Beta/Gamma Average (CPM)	Beta/Gamma Range (CPM)	Comments
East (E)	North (N)											
N/A	N/A											Background Reading
Prepared By:											Date:	
Reviewed By:											Date:	

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM/M-3-2-2
Survey Data Conversion Form

Date of Survey:	Type of Radiation:
Instrument Serial #:	Calibration Due Date:
Detector Serial #:	Calibration Due Date:
E_s (Surface Efficiency):	E_i (Insturment Efficiency):
BKG Counts:	BKG Count Time (min):
Active Area of Detector Probe (cm^2):	MDC ($dpm/100cm^2$):

Grid Coordinates		Survey Point Number	Survey Point Count Time (min)	Gross Counts (cts)	Gross Count Rate (cpm)	Net Count Rate (cpm)	Total Contamination ($dpm/100cm^2$)	95% CL Uncertainty ($dpm/100cm^2$)
East (E)	North (N)							

Comments:

Prepared By:	Date:
Reviewed By:	Date:

PROCEDURE: Penn E&R/HPM/M-3-3

Alpha Surveys
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-3-3

Alpha Surveys

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04 4-1-04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

1.0 PURPOSE

The purpose of this procedure is to provide written instructions for measuring the static or scanning levels of alpha radiation on structural surfaces.

2.0 DEFINITIONS

Standoffs: Spacers used to keep the detector a specified distance from a surface.

Static Count: A count taken for a specified amount of time in a stationary location.

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Surface must be dry, free of foreign material, and relatively flat.

3.2 When performing an alpha survey the detector should be in contact with the surface or as close as possible.

3.3 Instrument must pass preoperational checks as outlined in Procedure Penn E&R/HPM/M-2-1 and the appropriate instrument procedure.

3.4 Additional guidance on performing alpha surveys is provided in NUREG-1575.

3.5 If the beta/gamma survey is part of a final status survey, refer to the appropriate final status survey plan for guidance.

4.0 EQUIPMENT

4.1 Appropriate calibrated survey meter and detector.

5.0 PROCEDURE

5.1 Presurvey

5.1.1 Select scaler mode.

5.1.2 Hold the detector in the air away from any potentially contaminated surfaces and perform a background count for the predetermined duration. Record the result in appropriate the survey documentation (e.g., survey maps, Form HPM/M-3-2-1).

5.2 Static Survey

5.2.1 Prior to performing a static survey, use the guidance provided in Procedure Penn E&R/HPM/M-2-2 to calculate the time required to achieve the desired Minimum Detectable Concentration (MDC) value. The desired MDC value should be a fraction of the acceptance criteria specified in the survey plan or other applicable technical-basis document.

5.2.2 Select scaler mode.

5.2.3 Position the detector within one-quarter inch (0.6 centimeter [cm]) of the surface to be surveyed. This may be accomplished by use of "standoffs" attached to the bottom of the detector.

5.2.4 Initiate a static count in accordance with the appropriate instrument procedure for the predetermined time duration.

5.2.5 Record the gross result in the appropriate survey documentation (e.g., survey maps, Form HPM/M-3-2-1). Go to Substep 5.4

5.3 Scan Survey

5.3.1 Prior to performing an alpha scan survey, use the guidances provided in Procedure Penn E&R/HPM-M-2-2 to determine the probability of detecting an area of contamination for given scan rates.

5.3.2 Select ratemeter mode.

5.3.3 Position the detector within one quarter inch (0.6 cm) of the surface to be surveyed. This may be accomplished by use of standoffs attached to the bottom of the detector.

5.3.4 Slowly pass the detector across the surface to be surveyed at a rate of lateral motion not to exceed half a probe width per second. Due to the delicate nature of the probe face, care must be taken to avoid damage by rough surfaces or sharp objects.

5.3.5 Listen for a change in the audible count rate and observe for changes in the analog/digital reading. The surveyor must be careful to listen for subtle audible count rate increases (1 to 3 counts) which will occur before a visual increase in needle deflection or digital readout. The surveyor must hold the probe on this area for at least one second to determine the actual reading. It may be necessary to slow down the scan rate to one quarter of a probe width per second to reach the audible detection threshold.

5.3.6 Mark any areas of elevated activity using paint, grease pencil, survey flags, or other methods, depending on the survey location.

5.3.7 Traverse the survey area at very close intervals. Best results are obtained when the areas under the probe overlap. This is due to two factors. The first is the directional dependence of the probe. The second is due to the short range of alpha particles.

5.3.8 Record the gross results in the appropriate survey documentation (e.g., survey maps, Form HPM/M-3-2-1).

5.4 Data Conversion

5.4.1 Calculate the beta\gamma disintegrations per minute (dpm)/100 square cm (cm^2) by using the following equation and record on Penn E&R/HPM/M-3-2-2 or other appropriate documentation.

Alpha dpm/100 cm^2 = ((c/m – B/m)/E)*(100/A)

Where:

c/m = total count rate from instrument in counts per minute
B/m = background count rate (predetermined background radiation level taken from an unaffected area)
A = active surface area of the detector in cm^2
E = efficiency of instrument in counts per disintegration (cpd)

= E_i x E_s, Where:

E_i = 2π instrument efficiency (cpd) from the calibration certificate
E_s = source efficiency, 0.25

5.4.2 Calculate the 95% confidence level uncertainty (2 sigma uncertainty) in units of dpm/100cm2 using the following equation and record on HPM/M-3-2-2 or other appropriate documentation:

$$95\%\ \text{CL Unc.} = 1.96\frac{\sqrt{(samplecounts/(sampletime^2)) + (bkgcounts/(bkgtime^2))}}{(E_i x E_s x (A/100))}$$

6.0 REFERENCES

6.1 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG/CR-1575, August 2000, Rev. 1.

7.0 ATTACHMENTS

7.1 Forms

HPM/M-3-2-1 Decommissioning Survey Data Form

HPM/M-3-2-2 Survey Data Conversion Form

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Decommissioning Survey Data Form

Form ESC/HPM/M-3-2-1

Survey Number:		Survey Date:		Survey Type:	
Location:				Notes:	
Surveyor(s):					

Grid Coordinates		Survey Point Number	A/B Detector S/N	A/B Survey Instrument Serial Number	Survey Instrument Calibration Date	Alpha Count Rate (CPM)	Beta/Gamma Count Rate (CPM)	Alpha Scan Average (CPM)	Alpha Scan Range (CPM)	Beta/Gamma Average (CPM)	Beta/Gamma Range (CPM)	Comments
East (E)	North (N)											
N/A	N/A											Background Reading

Prepared By:	Date:
Reviewed By:	Date:

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM/M-3-2-2
Survey Data Conversion Form

Date of Survey:	Type of Radiation:
Instrument Serial #:	Calibration Due Date:
Detector Serial #:	Calibration Due Date:
E_s (Surface Efficiency):	E_i (Insturment Efficiency):
BKG Counts:	BKG Count Time (min):
Active Area of Detector Probe (cm^2):	MDC ($dpm/100cm^2$):

Grid Coordinates		Survey Point Number	Survey Point Count Time (min)	Gross Counts (cts)	Gross Count Rate (cpm)	Net Count Rate (cpm)	Total Contamination ($dpm/100cm^2$)	95% CL Uncertainty ($dpm/100cm^2$)
East (E)	North (N)							

Comments:

Prepared By:	Date:
Reviewed By:	Date:

PROCEDURE: Penn E&R/HPM/M-3-4

Exposure Rate Surveys
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-3-4

Exposure Rate Surveys

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04 4-1-04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

1.0 PURPOSE

The purpose of this procedure to provide written instruction for measuring gamma exposure rate levels.

2.0 DEFINITIONS

Background Exposure Rate: A radiation exposure rate that occurs naturally in the environment. Background exposure rate would include exposure to cosmic radiation from outer space, terrestrial radiation from the radioactive elements in rocks and soil, and radiation from radon and its decay products in air.

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 The instrument to be used must pass the preoperational checks as outlined in Procedure Penn E&R/HPM/M-2-1 and the appropriate instrument procedure.

3.2 Background measurements for land areas should be collected at locations which are unaffected by effluent releases (upwind and upstream) and other site operations (upgradient from disposal areas).

3.3 Locations of potential runoff from areas of surface contamination and locations that may have been affected or disturbed by nonsite activities should also be avoided.

4.0 EQUIPMENT

4.1 A Ludlum Model 19μR, or equivalent, with an internal 1-inch-by-1-inch sodium iodide scintillator.

5.0 PROCEDURE

5.1 All Surveys

5.1.1 Complete the preoperational checks in accordance with Procedure Penn E&R/HPM/M-2-1 and the appropriate instrument procedure.

5.1.2 Establish the background exposure rate for the area to be surveyed. Background is determined by measurements at locations on site or in the immediate vicinity of the site (out to several kilometers from the site boundary), which are unaffected by site operations. All measurements should be taken at approximately 1 meter above ground. Take measurements in accordance with Section 5.2.

5.1.3 To obtain an accurate background measurement, six to 10 measurements will be taken above unaffected areas and a confidence level of 95 percent determined to ensure accuracy. The equation for determining the of samples is as follows:

$$n_B = \left[\frac{t_{95\%,df} * S_x}{0.2 * \bar{x}_B} \right]^2$$

Where:

n_B = Number of background measurements required

$\bar{x}_B$ = Mean of initial background measurements

s_x = Standard deviation of background measurements

$t_{95\%, df}$ = t Statistic for 95 percent confidence at df = n-1 degrees of freedom, where n is the number of initial background data points. A table of t values is provided in Procedure Penn E&R/HPM/M-2-1.

5.1.4 If the above calculation indicates that additional background measurements are needed, it is recommended that they be collected uniformly over the area, using the same methodology as that used for the initial measurements. The average background is then recalculated using all data points.

5.2 General Area Survey

5.2.1 Position the detector approximately 1 meter above the surface to be surveyed.

5.2.2 Listen for a change in audible response and watch for needle deflection on the analog readout.

5.2.3 Record result on Form HPM/M-3-1-1 or survey map.

5.3 Contact Survey

5.3.1 Position the detector within one-quarter inch (0.6 centimeter [cm]) of the surface to be surveyed.

5.1.5 Listen for a change in the audible count rate and observe for changes in needle deflection.

5.1.6 Mark any areas of elevated activity, as necessary.

5.1.7 Record the results in the appropriate survey documentation (e.g., survey maps, Form HPM/M-3-1-1).

5.4 Scan Survey

5.4.1 Position instrument within 10 cm of the surface to be scanned.

5.4.2 Slowly move the instrument across the surface to be scanned at a rate of lateral motion not to exceed 0.5 meter per second.

5.4.3 Listen for a change in audible response and watch for needle deflection on the analog readout.

5.4.4 Mark any areas of elevated activity, as necessary.

5.4.5 Record the results on Form HPM/M-3-1-1 or survey map.

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

6.0 REFERENCES

6.1 NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG/CR-1575, August 2000, Rev. 1.

7.0 ATTACHMENTS

NA

PROCEDURE: Penn E&R/HPM/M-3-5

Removable Alpha and Beta / Gamma Contamination Surveys

Former Kaiser Aluminum Specialty Products Facility

Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-3-5

Removable Alpha and Beta/Gamma Contamination Surveys

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Procedure: **Penn E&R/HPM/M-3-5**

Title: **Removable Alpha and Beta/Gamma Communication Surveys**

1.0 PURPOSE

The purpose of this procedure is to provide written instruction for the collection and counting of removable alpha/beta structural surface contamination samples.

2.0 DEFINITIONS

Swipe: A cloth or paper disc that is wiped on the surface of an area or object being surveyed. Also referred to as a *smear.*

Chain of Custody (COC): An unbroken trail of accountability that ensures the physical security of samples, data, and records.

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Ensure the area surveyed by the swipe is approximately 100 square centimeters (cm^2).

3.2 Additional guidance on performing removable contamination surveys is provided in NUREG-1575.

4.0 EQUIPMENT

4.1 Swipes

4.2 Gloves (latex, nitrile, canvas, etc.)

5.0 PROCEDURE

5.1 Label the swipe to ensure the result is associated with the proper area. Some swipes come with an adhesive-type back and are adhered to a cover paper with an area for labeling. These swipes are preferred.

5.2 Hold the swipe so that the collection area will contact the surface being surveyed.

5.3 Wipe the area to be surveyed over a 100 cm^2 area (about a 4-inch-by-4-inch area) in a back-and-forth motion. An alternate method is to wipe the surface using an "S" motion that is 9 inches from top to bottom and from side to side.

5.4 Close the cover of the swipe or place in an envelope or bag. Several swipes may be placed in one envelope or bag, depending on the potential for cross contamination.

5.5 Label the bag as appropriate.

5.6 Count on an appropriate counter (e.g., Ludlum Model 2929, et al.) utilizing appropriate procedures; or

5.7 Complete a COC and submit to the selected laboratory for analysis.

5.8 Log the swipe including the date, time taken, and results of the counting (if available) on Form HPM/M-3-5-1.

5.9 If counted per Step 5.6, convert the counts per minute result to disintegrations per minute (dpm)/100 cm^2

using the following equation and record on Form HPM/M-3-2-2:

$$dpm/100cm^2 = \frac{(c_s/t_s)-(c_b/t_b)}{E}$$

Where:

c_s = counts recorded for sample
c_b = counts recorded for background
E = the detection efficiency of the instrument in counts per disintegration
t_s = the time period (in minutes) over which the count was recorded for the sample
t_b = the time period (in minutes) over which the count was recorded for the background sample

5.10 Calculate the 95% confidence level uncertainty (2 sigma uncertainty) in units of dpm/100cm2 using the following equation and record on HPM/M-3-2-2 or other appropriate documentation:

$$95\%\ \text{CL Unc.} = 1.96\frac{\sqrt{(samplecounts/(sampletime^2)) + (bkgcounts/(bkgtime^2))}}{(E_i)}$$

6.0 REFERENCES

6.1 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG/CR-1575, August 2000, Rev. 1.

7.0 ATTACHMENTS

7.1 Forms

Form HPM/M-3-5-1 Sample Log for Ludlum Model 2929 with a 43-10-1 Detector

Form HPM/M-3-2-2 Survey Data Conversion Form

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM/M-3-5-1
Sample Log for Ludlum Model 2929 with a 43-10-1 Detector

Instrument Model:	2929
Instrument S/N:	
Detector Model:	43-10-1
Detector S/N:	
Calibration Due:	

Source S/N:	N/A	N/A
Source Amount	N/A	N/A
Radiation Detected:	Alpha	Beta
Acceptable Range:		
(Refer to Penn E&R/HPM/M-2-1-1)		

Date	Background Count Rate Alpha (cpm)	Background Count Rate Beta (cpm)	Gross α Sample Count Rate (cpm)	Gross β Sample Count Rate (cpm)	Net α Sample Count Rate (cpm)	Net β Sample Count Rate (cpm)	α Contamination (dpm/100 cm^2)	β Contamination (dpm/100 cm^2)	Technician	Comments

Prepared By:	Date:
Reviewed By:	Date:

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM/M-3-2-2
Survey Data Conversion Form

Date of Survey:	Type of Radiation:
Instrument Serial #:	Calibration Due Date:
Detector Serial #:	Calibration Due Date:
E_s (Surface Efficiency):	E_i (Insturment Efficiency):
BKG Counts:	BKG Count Time (min):
Active Area of Detector Probe (cm^2):	MDC ($dpm/100cm^2$):

Grid Coordinates		Survey Point Number	Survey Point Count Time (min)	Gross Counts (cts)	Gross Count Rate (cpm)	Net Count Rate (cpm)	Contamination ($dpm/100cm^2$)	95% CL Uncertainty ($dpm/100cm^2$)
East (E)	North (N)							

Comments:

Prepared By:	Date:
Reviewed By:	Date:

PROCEDURE: Penn E&R/HPM/M-3-6

Gross Gamma Surveys of Soil Cores
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-3-6

Gross Gamma Surveys of Soil Cores

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

1.0 PURPOSE

The purpose of this procedure is to provide instruction for performing gross gamma surveys of soil boring cores (soil cores) and the subsequent sampling of the core.

2.0 DEFINITIONS

Soil Core: A soil sample obtaining by boring down vertically through soil, usually in 4-foot increments. The resulting sample is a cylinder in shape with a constant diameter.

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Instrument must pass preoperational checks as outlined in Procedure Penn E&R/HPM/M-2-1 and the appropriate instrument procedure. Ensure the preoperational and source checks have been completed prior to initiating survey.

3.2 Background count rates may vary. Background should be at least daily for each area and counting geometry to be used.

3.3 Before initiating a gross gamma soil survey be sure to record the instrument serial number(s), calibration date(s), date of survey, time of survey, and any other pertinent information.

3.4 The sodium iodide (NaI) detector may be shielded with at least 1/16 inch of lead.

3.5 The detector and the scaler should be configured so that the Health Physics Technician can move the core past the detector while observing the count rate and hear the audible response.

3.6 Ensure that the NaI detector is in the standard counting configuration for the type of survey to be performed, (e.g., inside of the shield, at a low background location).

3.7 Ensure that samples are properly labeled by location and depth of collection.

4.0 EQUIPMENT

4.1 2-inch-by-2-inch NaI scintillator detector, Ludlum Model 44-10, or equivalent

4.2 Ludlum Model 2221 Scaler, or equivalent

4.2 Sturdy Mixing Bucket, or equivalent and trowel

5.0 PROCEDURE

Record the results of measurements on Form HPM/M-3-6-1. Sections of the form that are not applicable to the survey should be marked "N/A." At a minimum, each soil core sample selected for survey should be scanned to identify the most elevated 1-foot section.

5.1 Determine Background

5.1.1 Ensure that the NaI detector is in the standard counting configuration, (e.g., inside of the shield, at the location that scans or fixed counts are to be performed).

5.1.2 Perform five consecutive 1-minute fixed counts with the detector in the desired standard scanning configuration (Ambient Background Geometry). A phantom core segment of background soil may be used to establish background.

5.1.3 Calculate the average background count rate.

5.2 Perform Soil Core Scan

5.2.1 Record the soil core serial number, (e.g. location and depth interval).

5.2.2 With the instrument in the rate mode, move the detector (or the soil core) at a rate of no greater than 1 inch per second, keeping the detector as close as possible to the soil core. Ensure that the scan rate is slow enough to detect changes in the audible response of the instrument.

5.2.3 Record the maximum count rate observed for each 1-foot segment of the soil core. Core segments are 0 to 1 foot, 1 to 2 feet, 2 to 3 feet, etc.

5.3 Label the sample container with sample location and depth interval.

5.4 Calculate the net counts per minute for each measurement by subtracting the appropriate average background, i.e., ambient background for scan measurements and the sample container background for fixed counts.

5.5 Sample and/or archive the core sample in accordance with the survey plan.

6.0 REFERENCES

6.1 Penn E&R/HPM/M-2-1, Basic Instrument Operation

7.0 ATTACHMENTS

7.1 Forms

Form HPM/M-3-6-1 Soil Core Gross Gamma Survey

Penn ER
359 North Gate Drive
Warrendale, PA 15086
724/934/3530

Form HPM-3-6-1
Soil Core Gross Gamma Survey

Effective Date: March 2004
Revision: 0

Date:		Time:		Instrument/SN:	
Background Counts					
Ambient Geometry	(cpm)	Core Phantom Geometry	(cpm)	Sample Container Geometry	(cpm)
Air-1		Core-1		Container-1	
Air-2		Core-2		Container-2	
Air-3		Core-3		Container-3	
Air-4		Core-4		Container-4	
Air-5		Core-5		Container-5	
Average:		Average:		Average:	
Core Counts					
Core Number / Segment	Gross Count Rate (cpm)	Net Count Rate (cpm)	Core Number / Segment	Gross Count Rate (cpm)	Net Count Rate (cpm)
Comments:					
Prepared By:				Date:	
Reviewed By:				Date:	

form3-6-1.xls

Chapter 4

Sampling

PROCEDURE: Penn E&R/HPM/M-4-1

Surface Soil Sampling
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-4-1

Surface Soil Sampling

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Procedure: **Penn E&R/HPM/M-4-1**

Title: **Surface Soil Sampling**

1.0 PURPOSE

The purpose of this procedure is to provide instruction for the collection of surface soil samples.

2.0 DEFINITIONS

Chain of Custody: An unbroken trail of accountability that ensures the physical security of samples, data, and records.

3.0 PREREQUISITES PRECAUTIONS/LIMITATIONS

3.1 Surface soil contamination criteria specify the average concentration in the upper 15 centimeters (cm) (6 inches) of soil. For this reason, care must be used to ensure that surface soil samples are collected only from the upper 15 cm of soil.

3.2 Check the applicable health and safety guidance for the site to be sampled. Ensure the proper protocol and other precautions delineated in the appropriate documents (e.g., Site Health and Safety Plan, Safety Work Permit, etc.) are followed.

3.3 Additional guidance on performing soil sampling surveys is provided in NUREG-1575.

4.0 EQUIPMENT

4.1 Garden trowel, spoon, or shovel

4.2 Plastic bags and twist ties or "ziplock"-type bags, or equivalent sample containers

4.3 Masking tape

4.4 Indelible marking pens

4.5 Sampling equipment cleaning supplies

4.6 Logbook or data sheets

5.0 PROCEDURE

5.1 Preparation

5.1.1 Remove rocks, vegetation, and other obstructions in the area selected for surface soil sampling.

5.1.2 Loosen the soil at the selected sampling locations to a depth of 15 cm (6 inches) using a trowel or other digging implement.

5.1.3 Prepare an appropriate sample container for sample collection. The laboratory that will receive the sample may specify a preferred sample container.

5.1.4 Label the container with indelible marker in accordance applicable guidance for the site.

5.2 Collection

5.2.1 A surface soil sample will be taken at each sample point, for a given location at a depth of 15 cm (6 inches).

5.2.2 Collect an appropriate aliquot (e.g., approximately 1 kilogram) of soil and place it into the prepared container. Be sure that the soil is thoroughly mixed.

5.2.3 Record the sample identification, location, and any other pertinent information and complete a *chain of custody* in accordance to the laboratory instructions.

5.2.4 Clean the sampling tools, as necessary, prior to proceeding to the next sample collection point.

6.0 REFERENCES

NA

7.0 ATTACHMENT

NA

PROCEDURE: Penn E&R/HPM/M-4-4

Subsurface Soil Sampling
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

J.W. Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-4-4

Subsurface Soil Sampling

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Earth Sciences Consultants, Inc.
One Triangle Lane
Export, PA 15632
(724) 733-3000

Procedure: ESC/HPM/M-4-4

Title: Subsurface Soil Sampling

1.0 PURPOSE

The purpose of this procedure is to provide instruction for the collection of subsurface soil samples also referred to as core samples.

2.0 DEFINITIONS

NA

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 Surface samples refer to soil samples not exceeding depths of 15 centimeters from the surface. Subsurface (core) samples refer to samples that exceed 15 centimeters from the soil surface.

4.0 EQUIPMENT

4.1 Tools, equipment, and material required include:

- Core boring equipment
- Core bore sampling apparatus
- Sample containers
- Indelible marking pen
- Trowel or spatula
- Log book or record sheets
- Sampling equipment cleaning supplies

5.0 PROCEDURE

5.1 Subsurface Sampling

5.1.1 Drive hollow-core tube (typically 2 to 4 feet in length) into ground at desired location using appropriate boring equipment.

5.1.2 Remove collected core sample.

5.1.4. Label the core sample with project number, sample identification, time and date of collection, and location and depth interval.

5.1.5. Log physical properties of soil core sample in field book or Form HPM/M-4-4-1. Collect additional core samples at desired sample location as needed.

5.1.7 Clean core boring and sampling equipment between each sample collection in accordance with project technical guidance document.

6.0 REFERENCES

NA

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

7.0 ATTACHMENTS

7.1 Forms

Form HPM/M-4-4-1 Sample Log for Core Samples

Penn ER
359 North Gate Drive
Warrendale, Pa 15086
724/934/3530

Form HPM/M-4-4-1
Sample Log for Core Samples

Client:		Project Number:	
Location:		Boring Number:	
Date Started:		Field Scientist:	
Date Completed:		Checked By/Date:	
Driller:		Page ____ of ____:	

Depth (Feet)	Sample Number and Type	SPT Blows (6")	RQD (%)	Sample Recovery (%)	OVA Reading (ppm)	Field Scan of Core (cpm)	Profile	Profile Description
(0-1)								
(1-2)								
(2-3)								
(3-4)								
(4-5)								
(5-6)								
(6-7)								
(7-8)								
(8-9)								
(9-10)								
(10-11)								
(11-12)								
(12-13)								
(13-14)								

Comments:	
Prepared By:	Date:
Reviewed By:	Date:

Chapter 5

Quality Assurance

PROCEDURE: Penn E&R/HPM/M-5-2

Check Source Accountability
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

Bill Vinzant

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-5-2

Check Source Accountability

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Procedure: **Penn E&R/HPM/M-5-2**

Title: **Check Source Accountability**

1.0 PURPOSE

The purpose of this procedure is to ensure that the check sources that are used for daily instrument checks are kept under positive control.

2.0 DEFINITIONS

Positive control: The ensurement that access to sources is restricted.

Check source: Sources of radiation that are used to periodically assure the operation of calibrated instruments.

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 This procedure is only to be implemented on sealed sources that do not fall under the exempt quantities limits set by 10 Code of Federal Regulations (CFR) 39.35.

3.2 Sealed sources that only emit alpha particles require leak testing every 3 months.

3.3 Sealed sources that are neutron, beta, gamma, or a combined alpha emitter require leak testing every 6 months.

3.4 It is recommended that the surveying individuals handling the sealed source wear surgeons' gloves or forceps. The natural oils that are released by the human body can, over time, degrade the finish of the electroplated isotopes. Also, a build up of oil may cause inaccuracy when using the sealed sources as check sources.

4.0 EQUIPMENT

- Cotton swabs
- DI water
- Sample containers
- Appropriate instrumentation (i.e., gas proportional)
- Surgical gloves
- Forceps

5.0 PROCEDURE

5.1 Accountability

5.1.1 All check sources that are to be used for instrument calibration shall be kept under positive control by the on-site employee(s). Positive control on location includes securing sources when not in use, documentation when they are used for calibration checks, and supervision of the check source when it is being used.

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

5.2 Leak Testing

5.2.1 Establish Background

5.2.1.1 Background will be established by following the guidance provided by the manufacturer. Be sure to use a dampened cotton swab for determining background. This will ensure that the counting of the surveys contains the same geometry as the background counting.

5.2.1 Surveying Sealed Sources

5.2.1.1 Record all information that accompanies each particular sealed source (i.e., serial number, isotope, origin date, responsible person, decay method, date, time, and survey interval).

5.2.1.2 Dampen a cotton swab and survey the source. The survey is done by swabbing all edges, seams, and openings where it may be possible for the sealed source to "leak" or breakdown.

5.2.1.3 Only one swab is usually required per source. However, this may vary due to the physical dimensions of some particular sources.

5.2.1.4 After swabbing is complete, each swab is placed in a labeled sample container until it is counted on the appropriate instrument to ensure that the source has retained its physical integrity.

5.2.1.5 Record all information obtained from counting the swabs.

5.2.1.6 If elevated readings are obtained from performing a survey on a sealed source the survey may be performed again. If the test reveals the presence of 0.005 mirocuries or more of removable radioactive material, the licensee shall remove the sealed source from service immediately and have it decontaminated, repaired, or disposed of in accordance with Nuclear Regulatory Commission guidelines for the disposal of that particular isotope.

6.0 REFERENCES

6.1 10 CFR 39.35, "Leak Testing of Sealed Screens"

7.0 ATTACHMENTS

NA

Chapter 6

Chain of Custody

PROCEDURE: Penn E&R/HPM/M-6-1

Chain – of – Custody Procedures
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

REVISION: 00

EFFECTIVE DATE: MARCH 2004

APPROVED BY: J.W. Vinzant, Project Manager

DATE: 3-31-04

PROCEDURE: Penn E&R/HPM/M-6-1

Chain-of-Custody Procedures

REVISION: 0

EFFECTIVE DATE: MARCH 2004

3/31/04

Prepared by: Date:
Andrew J. Lombardo
Civil & Environmental Consultants, Inc.

4-1-04

Approved by: Date:
Vice President – Radiological Services

Penn E&R
359 North Gate Drive Suite 400
Warrendale, PA 15086
724/934/3530

Procedure: **Penn E&R/HPM/M-6-1**

Title: **Chain-of-Custody Procedures**

1.0 PURPOSE

The purpose of this procedure is to provide instruction for filling out the necessary chain-of-custody forms for samples.

2.0 DEFINITIONS

Chain of Custody: An unbroken trail of accountability that ensures the physical security of samples, data, and records.

3.0 PREREQUISITES/PRECAUTIONS/LIMITATIONS

3.1 A chain of custody must be filled out before relinquishing control of the sample.

3.2 Exert positive control of radioactive or potentially radioactive samples. Do not leave samples unattended at any time.

4.0 EQUIPMENT

4.1 Chain-of-Custody Forms

5.0 PROCEDURE

5.1 Laboratory Chain of Custody

- Project name.
- Project number.
- Sampler – Name of person taking the sample (printed and signed).
- Relinquished by – Name of person giving up custody (printed and signed).
- Date and time – Enter date and time that the sample was turned over to a new custodian.
- Received by – Name of person taking custody (printed and signed).
- Date and time – Enter date and time that the sample was received from the old custodian.
- Enter the client sample identification number.
- Date and time – Enter date and time that the sample was taken.
- Enter the matrix type.
- Enter the number of containers.
- Enter container size and type – either plastic or glass.
- List what preservatives (if any) were used. If none, then list "NA".
- List any remarks that are pertinent to the samples.
- Enter the address of the party receiving the results.
- Enter the address of the party responsible for the billing.
- Enter requested turnaround time.
- Verify information on the sample container is the same as on the chain-of-custody form.

6.0 REFERENCES

NA

7.0 ATTACHMENTS

NA