RECON
Remedial Construction Services, L.P.

Form Numbers and Descriptions

Thorium Remediation Project

Form No.	Title	Effective Date	Rev. No.
REC-WP-2-01-1	PERFORMANCE CHECK VALUES	MAY 2004	01
REC-WP-2-01-2	PERFORMANCE CHECK VALUES FOR LUDLUM MODEL 19	MAY 2004	00
REC-WP-2-02-1	MONTHLY STATIC MDC COUNT TIME CALCULATION	MAY 2004	01
REC-WP-2-02-2	MONTHLY BETA MDC COUNT TIME CALCULATION	MAY 2004	01
REC-WP-2-02-3	MONTHLY ALPHA MDC COUNT TIME CALCULATION	MAY 2004	01
REC-WP-2-02-4	MONTHLY GAMMA MDC COUNT TIME CALCULATION	MAY 2004	01
REC-WP-2-03-1	DAILY CHECK LOG LUDLUM 2224 W/ 43-93 DETECTOR	MAY 2004	01
REC-WP-2-04-1	DAILY CHECK LOG LUDLUM 3 W/ 43-93 DETECTOR	MAY 2004	01
REC-WP-2-05-1	DAILY CHECK LOG LUDLUM 19	MAY 2004	01
REC-WP-2-06-1	DAILY CHECK LOG LUDLUM 177 W/ 44-9 DETECTOR	MAY 2004	01
REC-WP-2-07-1	DAILY CHEK LOG LUDLUM 2929 W/ 43-10-1 DETECTOR	MAY 2004	01
REC-WP-2-08-1	DAILY CHECK LOG LUDLUM 2221 W/ 43-5 DETECTOR	MAY 2004	01
REC-WP-2-09-1	LOST OR DAMAGED DOSIMETER REPORT	MAY 2004	01
REC-WP-3-01-1	SURVEY DATA LOG	MAY 2004	01
REC-WP-3-05-1	REMOVABLE ALPHA/BETA SURVEY SAMPLE LOG	MAY 2004	01
REC-WP-4-02-1	AIR SAMPLING DATA LOG	MAY 2004	01
REC-WP-4-02-2	AIR SAMPLING ENVELOPE	MAY 2004	01
REC-WP-4-02-3	AIR SAMPLING ANALYSIS LOG	MAY 2004	00
REC-WP-7-01-1	DISCHARGE TO SANITARY SEWER LOG	MAY 2004	01
REC-WP-7-05-1	DAILY BUCKET SCALE VERIFICATION LOG	MAY 2004	01
REC-WP-7-06-1	RAIL CAR INSPECTION FORM	MAY 2004	00
NRC FORM 5	OCCUPATION DOSE RECORD FOR A MONITORING PERIOD	MAY 2004	01
	OUTREACH LABORATORY CHAIN OF CUSTODY	MAY 2004	01
	EQUIPMENT INSPECTION FORM	MAY 2004	01

Form REC-WP-2-01-1
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	DPM
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

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 1 min the counts (10)

$\overline{x}$ = average of (10) 1 min counts

x_i^2 =each count result squared

$$StdDev = \sqrt{\frac{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} \overline{x}_i\right)^2}{n(n-1)}}$$

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

Form REC-WP-2-01-2
Performance Check Values
for
Ludlum 19

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 µR/hr:			

Data Point	Gross µR/hr	Net µR/hr
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Average Net µR/hr			
Standard Deviation of Net µR/hr			
20% of Net µR/hr			
Average minus 20%			
Average plus 20%			

Formulas

Where: n = number of 1 min the counts (10)

$\overline{x}$ = average of (10) 1 min counts

x_i^2 =each count result squared

$$StdDev=\sqrt{\frac{n\sum_{i=1}^{n}x_i^2-\left(\sum_{i=1}^{n}\overline{x}_i\right)^2}{n(n-1)}}$$

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

Form REC-WP-2-02-1
Monthly 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.

Form REC-WP-2-02-2
Monthly 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/100cm²)
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).

Form REC-WP-2-02-3
Monthly 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.

Form REC-WP-2-02-4
Gross Gamma Scan MDC Calculation

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

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

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

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

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).
mR/h = microRoentgen per hour.
pCi/g = Picocuries per gram.
ncpm = Net counts per minute.
E_i = Instrument efficiency (from Table 6.7 of MARSSIM).

Form REC-WP-2-03-1 Daily Check Log
Ludlum Model 2224 with 43-93 Detector

Instrument/SN: Ludlum Model 2224 /		***Check Source(s) Used:***
Detector/SN: Model 43-93 /		Date Calculated:
EFF % α= %, β= %	Total EFF % α= %, β= %	Calc. By: Alpha Beta
CALIB. SOURCE USED:		**Comments:**
DATE OF CALIB.:		
CALIB. DUE DATE:		
PERFORMED BY:		

TECHNICIAN'S NAME	ALPHA / BETA	DATE	TIME	background count time (minutes)	background counts	GROSS READING	**NET READING**	BATT. CHECK	NEEDS CALIB.		
	α										
	β										
	α										
	β										
	α										
	β										
	α										
	β										
	α										
	β										
	α										
	β										
	α										
	β										
	α										
	β										
	α										
	β										
	α										
	β										

Prepared By:	Date:
Reviewed By:	Date:

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Houston, TX 77064
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Form REC-WP-2-04-1
Daily Check Log for Ludlum Model 3 with 44-9 Detector

Instrument Model:	3
Instrument S/N:	
Detector Model:	44-9
Detector S/N:	
Calibration Due:	

Source S/N:	
Source DPM:	
Radiation Detected:	Alpha/Beta/Gamma
Acceptable Range: (Refer to REC-WP-2-01-1)	

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

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

Form REC-WP-2-05-1
Daily Check Log for Ludlum Model 19

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 REC-WP-2-01-1)	

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

Comments:

Prepared By:	Date:
Reviewed By:	Date:

Page ____

Form REC-WP-2-06-1
Daily Check Log for Ludlum Model 177 with 44-9 Detector

Instrument Model:	177
Instrument S/N:	
Detector Model:	44-9
Detector S/N:	
Calibration Due:	

Source S/N:	
Source DPM:	
Radiation Detected:	Alpha/Beta/Gamma
Acceptable Range: (Refer to REC-WP-2-01-1)	

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

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

Form REC-WP-2-07-1
Daily Check 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:		
Source Amount		
Radiation Detected:	Alpha	Beta
Acceptable Range:		
Background Count Time:		

Date	Background Count Rate Alpha (cpm)	Background Count Rate Beta (cpm)	Gross a Source Count Rate (cpm)	Gross b Source Count Rate (cpm)	Net a Source Count Rate (cpm)	Net b Source Count Rate (cpm)	Technician	Comments

Prepared By:	Date:
Reviewed By:	Date:

Form REC-WP-2-08-1 Daily Check Log
Ludlum Model 2221 with 43-5 Detector

Instrument/SN: Ludlum Model 2221 /		*Check Source(s) Used:*
Detector/SN: Model 43-5 /		Date Calculated:
EFF % α = %, β= %	Total EFF % α = %, α= %	Calc. By: Alpha

CALIB. SOURCE USED:

DATE OF CALIB.:

CALIB. DUE DATE:

PERFORMED BY:

Comments:

TECHNICIAN'S NAME	ALPHA	DATE	TIME	background count time (minutes)	background counts	GROSS READING	**NET READING**	BATT. CHECK	NEEDS CALIB.		
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										
	α										

Prepared By: Date:

Reviewed By: Date:

Form REC-WP-2-09-1
Lost or Damaged Dosimeter Report

Name:______________________ Date:______________________________

SSN:______________________ Date Lost or Damaged:______________

Dosimeter Number:______________

Location Lost:____

Remarks:____

____

____

____

____
Signature

____
Radiation Safety Officer

Actions Taken:____

____

____
Reviewed By

Form REC-WP-3-01-1
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:

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Revision 01
May 2004

Form REC-WP-3-05-1
Removable Alpha/Beta Survey Sample Log 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 REC-WP-2-01-1)		

Date	Background Count Rate Alpha (cpm)	Background Count Rate Beta (cpm)	Gross a Sample Count Rate (cpm)	Gross b Sample Count Rate (cpm)	Net a Sample Count Rate (cpm)	Net b Sample Count Rate (cpm)	a Contamination (dpm/100 cm²)	b Contamination (dpm/100 cm²)	Technician	Comments

Prepared By:	Date:
Reviewed By:	Date:

Form REC-WP-4-02-1
Air Sample Data Log

Date of Survey:	Ambient Conditions:
Instrument Serial #:	
Calibration Due Date:	
BKG Counts:	
Derived Air Concentration (DAC) 2.00E-12 uCi/ml	

Placement Location	Flow Rate (lpm)	Pump Start Time	Pump Stop Time	Elapsed Time (min)	Volume Collected (liters)	Laboratory Result	µCi/ml	Fraction of DAC

Prepared By:	Date:
Reviewed By:	Date:

Form REC-WP-4-02-2
Air Sample Envelope

Date: ______________________ Sample # ____________

Time On: ______________________ Sampler ID # ____________

Time Off: ______________________ Total Min: ____________

Flow: ______________________ Volume: ____________

Technician: ____

Location: ____

Reason: ____

Remedial Construction Services, L.P. (Recon)
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Form REC-wP-4-02-3
Air Sampling Analysis Log

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	
Acceptable Range:		
(Refer to REC-WP-2-01-1)		

Date	Background Count Rate Alpha (cpm)	Gross a Sample Count Rate (cpm)	Net a Sample Count Rate (cpm)	Technician	Comments

Prepared By:	Date:
Reviewed By:	Date:

Form REC-WP-7-01-1
Discharge to Sanitary Sewer Log

Date	Storage Tank ID	Discharge Start Time	Meter Reading Prior to Discharge	Discharge Stop Time (or at verification)	Meter Reading Post Discharge (or at verification)	Net Gallons Discharged (or at verification)	Technician	Daily Verification (To be done AM & PM)			
								Elapsed Time	GPM	Elapsed Time	GPM

Reviewed by: ______________________________

Form REC-WP-7-05-1
Daily Bucket Scale Verification Log

Date	Operators Name	Verified Weight	Recorded Weight	Within Verification Limits Yes/No	Comments

Reviewed by: ______________________________

Form REC-WP-7-06-1
RAIL CAR INSPECTION FORM

DATE:____/____/____ INSPECTOR:_______________

TIME:__________AM/PM SIGNED:___________________

Each inbound rail car shall be inspected before loading for presence of a potential problem which may effect the operation of the rail car, or which may lead to an event which would cause a threat to human health or the environment. For each item identify the inspection areas as Acceptable (A) or Not Acceptable (N). Acceptable also means "Step completed". Any deficient items shall be marked, reported and the date and nature of the corrective action taken. If an item is not inspected, mark "NI" (Not Inspected).

Rail Car #________________

Condition/Inspection Area	A / N / NI	Comments
Is the Car body leaning or listing significantly to the side?	[ ] [ ] [ ]	__________
Is the Car body sagging downward?	[ ] [ ] [ ]	__________
Is the Car body position improperly on the tracks?	[ ] [ ] [ ]	__________
Is the Car body or portions of the car dragging?	[ ] [ ] [ ]	__________
Are objects extending from the side of the car body?	[ ] [ ] [ ]	__________
Is the floor of the rail car damaged?	[ ] [ ] [ ]	__________
Is the interior of the car clean and free of dirt/debris?	[ ] [ ] [ ]	__________
Are the sides of the rail car damaged or torn?	[ ] [ ] [ ]	__________
Are the couplers connected and secure?	[ ] [ ] [ ]	__________
Inspected for overheated wheels or journals (bearings)?	[ ] [ ] [ ]	__________
Are brakes free or do any brakes fail to release?	[ ] [ ] [ ]	__________
Are tracks free and clear of obstructions?	[ ] [ ] [ ]	__________
Are the wheel chocks secured?	[ ] [ ] [ ]	__________
Is the derailer in proper position?	[ ] [ ] [ ]	__________
Are there any other apparent safety hazards likely to cause an accident, injury or casualty?	[ ] [ ] [ ]	__________
Damage (note below)	[ ] [ ] [ ]	__________

Remarks: Record Damage, Date and Nature of any Corrective Actions

____

____

____

____

Yard Master/Transportation Manager Contacted Time:________________Date:______

Rail Car Accepted: (Signature)____________________________Date:___________

NRC FORM 5 (10-2001) 10 CFR PART 20

U.S. NUCLEAR REGULATORY COMMISSION

OCCUPATIONAL DOSE RECORD FOR A MONITORING PERIOD

APPROVED BY OMB NO. 3150-0006 EXPIRES: 10/31/2004

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX	5. DATE OF BIRTH (MM/DD/YYYY)
			☐ MALE ☐ FEMALE	

6. MONITORING PERIOD (MM/DD/YYYY - MM/DD/YYYY)	7. LICENSEE NAME	8. LICENSE NUMBER(S)	9A.	9B.
			☐ RECORD	☐ ROUTINE
			☐ ESTIMATE	☐ PSE

INTAKES

10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN µCi

DOSES (in rem)

DEEP DOSE EQUIVALENT	(DDE)	11.
LENS (EYE) DOSE EQUIVALENT	(LDE)	12.
SHALLOW DOSE EQUIVALENT, WHOLE BODY	(SDE,WB)	13.
SHALLOW DOSE EQUIVALENT, MAX EXTREMITY	(SDE,ME)	14.
COMMITTED EFFECTIVE DOSE EQUIVALENT	(CEDE)	15.
COMMITTED DOSE EQUIVALENT, MAXIMALLY EXPOSED ORGAN	(CDE)	16.
TOTAL EFFECTIVE DOSE EQUIVALENT (ADD BLOCKS 11 AND 15)	(TEDE)	17. 0
TOTAL ORGAN DOSE EQUIVALENT, MAX ORGAN (ADD BLOCKS 11 AND 16)	(TODE)	18. 0

19. COMMENTS

20. SIGNATURE -- LICENSEE	21. DATE PREPARED

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF NRC FORM 5
(All doses should be stated in rems)

1. Type or print the full name of the monitored individual in the order of last name (include "Jr," "Sr," "III," etc.), first name, middle initial (if applicable).

2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.

3. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
PADS	PADS Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.

5. Enter the date of birth of the individual being monitored in the format MM/DD/YYYY.

6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YYYY - MM/DD/YYYY.

7. Enter the name of the licensee.

8. Enter the NRC license number or numbers.

9A. Place an "X" in Record, Estimate, or No Record. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee intends to assign the record dose on the basis of TLD results that are not yet available.

9B. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring period.

If more than one PSE was received in a single year, the licensee should sum them and report the total of all PSEs.

10A. Enter the symbol for each radionuclide that resulted in an internal exposure recorded for the individual, using the format "Xx-###x," for instance, Cs-137 or Tc-99m.

10B. Enter the lung clearance class as listed in Appendix B to 10 CFR Part 20.1001-2401 (D, W, Y, V, or O for other) for all intakes by inhalation.

10C. Enter the mode of intake. For inhalation, enter "H." For absorption through the skin, enter "B." For oral ingestion, enter "G." For injection, enter "J."

10D. Enter the intake of each radionuclide in μCi.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

15. Enter the committed effective dose equivalent (CEDE).

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ.

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.

19. COMMENTS.
In the space provided, enter additional information that might be needed to determine compliance with limits. An example might be to enter the note that the SDE,ME was the result of exposure from a discrete hot particle. Another possibility would be to indicate that an overexposed report has been sent to NRC in reference to the exposure report.

20. Signature of the person designated to represent the licensee.

21. Enter the date this form was prepared.

PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552a(e)(3), enacted into law by Section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the U.S. Nuclear Regulatory Commission (NRC) on NRC Form 5. This information is maintained in a system of records designated as NRC-27 and described at 65 Federal Register 56434 (September 18, 2000), or the most recent Federal Register publication of the NRC's "Republication of Systems of Records Notices" that is available at the NRC Public Document Room, 11555 Rockville Pike, Rockville, Maryland or located in NRC's Agencywide Documents Access and Management System (ADAMS).

1. **AUTHORITY:** 42 U.S.C. 2073, 2093, 2095, 2111, 2133, 2134, and 2201(o) (1996); 10 CFR 20.2106, 20.2201-20.2204, and 20.2206 (2000); Executive Order 9397, November 22, 1943.

2. **PRINCIPAL PURPOSE(S):** The information is used by the NRC in its evaluation of the risk of radiation exposure associated with the licensed activity and in exercising its statutory responsibility to monitor and regulate the safety and health practices of its licensees. The data permits a meaningful comparison of both current and long-term exposure experience among types of licensees and among licensees within each type. Data on your exposure to radiation is available to you upon your request.

3. **ROUTINE USE(S):** The information may be used to provide data to other Federal and State agencies involved in monitoring and/or evaluating radiation exposure received by individuals monitored for radiation exposure while employed by or visiting or temporarily assigned to certain NRC licensed facilities; to return data provided by licensee upon request. The information may also be disclosed to an appropriate Federal, State, local or Foreign agency in the event the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding. In addition, this information may be transferred to an appropriate Federal, State, local and Foreign agency to the extent relevant and necessary for an NRC decision about you or to the extend relevant and necessary for that agency's decision about you. Information from this form may also be disclosed, in the course of discovery and in presenting evidence, to a Congressional office to respond to their inquiry made at your request, or to NRC-paid experts, consultants, and others under contract with the NRC, on a need-to-know basis.

4. **WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION:** It is voluntary that you furnish the requested information, including social security number (identification number); however, the licensee must complete NRC Form 5 on each individual for whom personnel monitoring is required under 10 CFR 20.2106. Failure to do so may subject the licensee to enforcement action in accordance with 10 CFR 20.2401. The social security number (identification number) is used to assure that NRC has an accurate identifier not subject to the coincidence of similar names or birth dates among the large number of persons on who data is maintained.

5. **SYSTEM MANAGER(S) AND ADDRESS:**
REIRS Project Manager
Radiation Protection and Health Effects Branch
Division of Regulatory Applications
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

OUTREACH TECHNOLOGIES, INC.

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CLIENT	BILL TO:
CONTACT	CONTACT
ADDRESS	ADDRESS
CITY STATE ZIP	CITY STATE ZIP
PHONE	PHONE
FAX	FAX

CHAIN OF CUSTODY RECORD

PROJECT NO. __________

PROJECT NAME __________

TURNAROUND TIME __________

SAMPLER __________
(SIGNATURE)

LAB SAMPLE #	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS												COMMENTS

RELINQUISHED BY	DATE	TIME	RECEIVED BY	RELINQUISHED BY	DATE	TIME	RECEIVED BY

RELINQUISHED BY	DATE	TIME	RECEIVED BY	RELINQUISHED BY	DATE	TIME	RECEIVED BY

REMARKS

Equipment Inspection Form

Thorium Remediation Project
Tulsa, Oklahoma

Job # ______________________ **Name:** ______________________

Daily Equipment Check List			Remarks	Hours Last Serviced
Date				Please note the hour reading recorded on the oil, air, fuel and hydraulic filters on the equipment.
Equipment				
Operator				
Hour Meter				
Start				
End				
Fluids Check List				
	Ok	**Add**		
Fuel Grease				
Oil				
Brake/Hydraulic				
Water				
Transmission				
Equipment Condition				
	Ok	**Repair**		
Glass				
Horn				
Lights				
Mirrors				
Seat Belt				
Step/Ladder				
Travel Alarm				
Wipers				
Tires				
Belts				
Air Filter				
Fuel Leaks				
Oil Leaks				
Hyd. Cylinders				
Steering				
Brakes				
Hoses				
Fire Extinguisher				

Comments

Mersino's Dewatering Trench Plan

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **01**

EFFECTIVE DATE: **MAY 2004**

Approved Bill Vinzant
J. W. (Bill) Vinzant – Project Manager

5-10-04
Date

Kaiser Aluminum & Chemical Corporation

Mersino's Dewatering Trench Plan

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **01**

EFFECTIVE DATE: **MAY 2004**

5/7/04
Danny P. Brown – Project Manager / Date

5/7/04
Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

Dewatering Trench Work Plan

Table of Contents

WORK PLAN

INSTALLATION OF SOCK DRAIN WITH STONE

Design Basis –

Trench depth is based on existing weathered shale elevations depicted in Figure 1, Dewatering Trench Stations and Depths. Based on this information the existing ground elevation will be leveled and graded to allow keying 4" – 5" into the weathered shale layer. As per design established by Mersino Trenching LLC., (MTLLC) the installation of approximately 3000 lf of a trenched tile dewatering system shall consist of three 1000 lf sections of perforated, sock cased corrugated 5" HDPE dewatering pipe with a sump at each end covered by approximately three feet (3') of 3/8" Class "A" washed stone to be utilized as the filter media. Backfilling operations will utilize excavated materials compacted and graded in place.

Procedure of Operation –

Prior to arrival at the jobsite all equipment will be decontaminated. The operator for Mersino Trenching LLC will unload the track machine off of the trailer. After the machine has been taken off of the trailer, the stone chute and stone hopper must be placed on the machine.

RECON will provide an excavator and operator to lift the stone chute (a long chute that attaches to the pipe box along top of the machine) to be pined in place.
After the chute is pinned in place the hopper will be lifted by the excavator and bolted in place on the brackets attached to the trencher.

The machine will then be tracked to the location of the first system to be installed.

Preparing for Installation of Dewatering System –

The first thing that needs to be done is to arrange everyone and every machine involved in one area.

The front-end loader, excavator & rock box needs to be set up right along side the trencher, and the stone piles have to be arranged close to the work site.

Before the operator starts trenching, the drainage pipe to be installed must be laid out along the work area. The pipe will be placed on a trailer that will be towed by a pickup truck. The trailer will be capable of spinning to make it easier to string out the pipe. Once the pipe is strung out along the area of the system, it can be fed into the machine. The machine has a pipe box attached to it on top of the chain boom. A solid piece of pipe will be fed manually into the pipe box form the bottom end. It will come out of the top and will lie towards the ground. When the solid pipe has been placed in the box, the drainage pipe will then be coupled to the solid pipe as to make it one continuous pipe, with a solid pipe coupled to the other end as well. When the pipe is hooked up installation can begin.

Installation of Dewatering System –

Once the pipe is strung out, the loaders are in place, and the stone is stockpiled close to the work zone, installation can begin.

The operator will start the engine on the trencher, and will begin turning the chain. The chain on the trencher has cutters that will do the digging. As the chain begins turning the operator will begin lowering his boom into the ground. Once he has started to lower his boom, the pipe will begin pulling itself into the ground.

After the chain boom is a few feet in the ground, the operator will then stop to allow the excavator to pour stone into the stone chute, and then in the hopper as well. This will allow stone to be placed into the cut right away. Now that the stone has been placed into the chute, the operator of the trencher can begin lowering his boom into the ground the rest of the way, keying into the weathered shale layer. As the boom reaches the desired depth, the operator will begin tracking the machine away from where it originally set in the ground. This will allow the pipe to pull itself into the ground. This will continue until the trencher reaches the end of the system.

Meanwhile, an excavator will fill the stone hopper with 3/8" Class A washed stone from a rock box being pulled by the excavator and continually filled by the front end loader. The excavator will continue to feed the trenching equipment until the machine reaches the end of the system. As the chain is turning in the ground it will bring up the soils out of the ground and place them back over the trench, backfilling the trench as it goes. After trench is compacted and graded to match existing ground, some additional excavated materials will be left on top of the ground upon completion, the materials will be stockpiled in a location that has positive drainage toward the retention pond.

Once the machine reaches the end of the system and the solid pipe has been laid in the ground for a few feet, the operator can raise his boom out of the ground. This will leave a solid pipe sticking out of the ground at each end. The purpose for the solid pipe is so that the dewatering can take place from the drainage pipe at the bottom of the cut, and not allow the system to suck air where it begins and ends. This procedure will be the same for each system installed.

Pumping of Dewatering Systems –

After the system(s) is installed, a 4" Wellpoint Pump will be placed at the desired end of the system(s) as per figure 5 and 8 in RECON's Work Plan. A short solid pipe will be coupled to the end of the system to allow it to reach the pump. After the temporary holding tanks are constructed the pump(s) will then be started up with the vacuum relief valve open (to allow slow build up of vacuum so the sock does not get plugged up). The contractor will then let the system pump for as long as desired before excavation. Water levels will be checked periodically through the existing piezometers/wells to monitor ground water levels.

Breakdown and Loading of MTLLC Trencher –

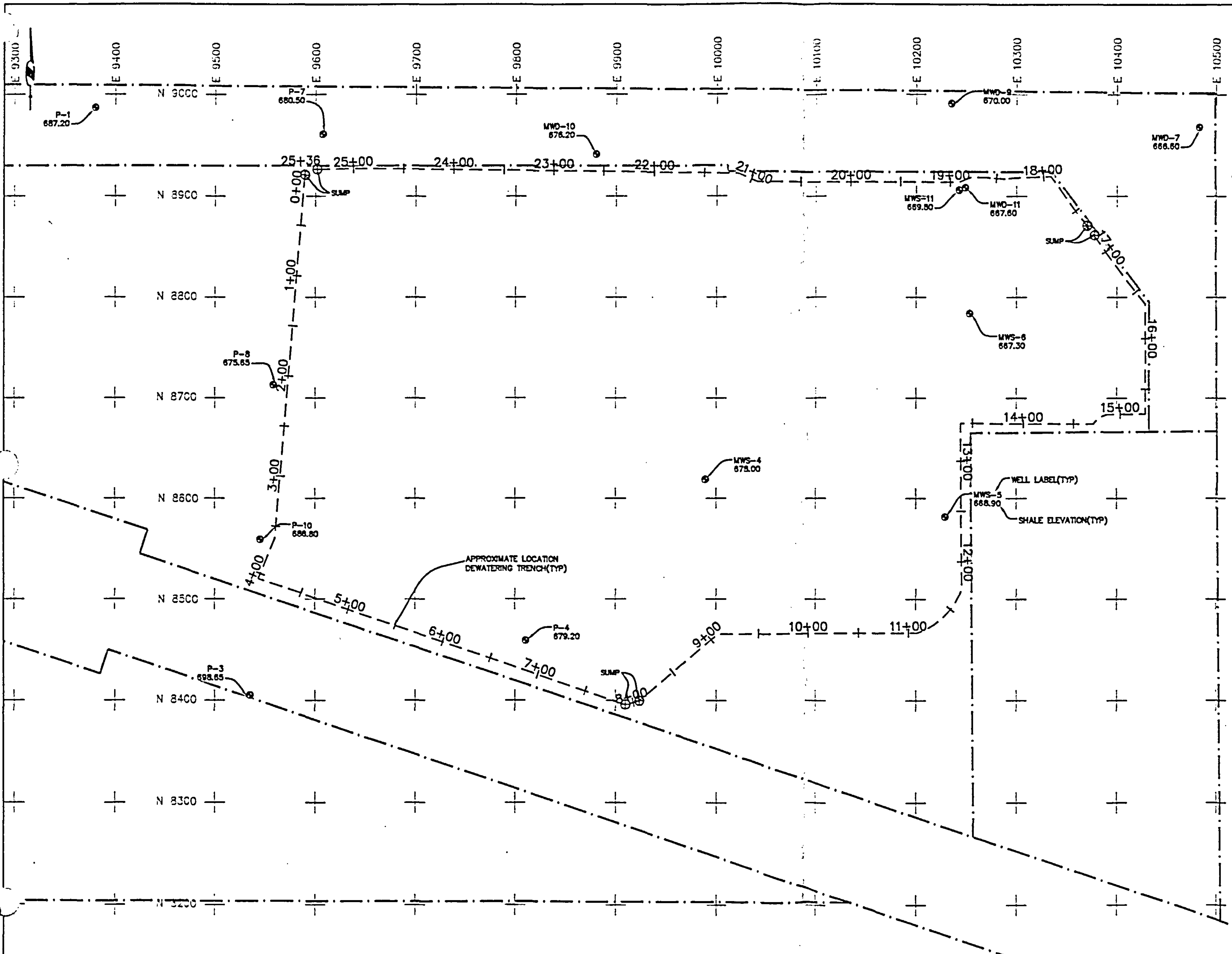
At the end of the installation of the dewatering systems, the contractor will use the excavator to remove the stone hopper and chute off of the trencher and load it back on the trailer. After the trencher is decontaminated and has passed the Unrestricted Release criteria as per the Radiation Health & Safety Plan (RHASP) the trencher will be loaded back onto the lowboy and chained down for transporting back to MTLLC's yard.

RECON will provide any necessary decontamination of the hopper, chute, service truck(s), trailer and machine.

MTLLC has agreed to adopt the Environmental Health & Safety Plan (EHASP) and RHASP plans set forth by RECON. The equipment that MTLLC will bring will be decontaminated prior to arrival on site.

When the dewatering trench can no longer be utilized RECON will cut off protruding piping six feet (6') below grade at each sump and cap the ends. RECON then will backfill, level and grade area.

Figure 1



STATION	EXISTING	SHALE	DEPTH
0+00	702.00	679.98	22.02'
1+00	700.21	677.86	22.35'
2+00	696.22	676.00	20.22'
3+00	699.69	681.44	18.25'
4+00	702.51	689.26	13.25'
5+00	700.66	686.89	13.77'
6+00	700.33	683.93	16.40'
7+00	700.80	NO DATA	
8+00	698.53	NO DATA	
9+00	696.12	NO DATA	
10+00	694.46	NO DATA	
11+00	692.04	NO DATA	
12+00	694.54	NO DATA	
13+00	694.98	NO DATA	
14+00	688.77	NO DATA	
15+00	689.00	NO DATA	
16+00	689.34	NO DATA	
17+00	690.06	NO DATA	
18+00	691.09	667.65	23.44'
19+00	694.00	669.83	24.17'
20+00	692.68	671.67	21.01'
21+00	696.00	673.29	22.71'
22+00	695.10	674.97	20.13'
23+00	695.03	676.80	18.23'
24+00	694.80	677.88	16.92'
25+00	697.17	679.32	17.85'
25+36	702.00	679.81	22.19'

PROPERTY LINE
BM BENCH MARK
DEWATERING TRENCH
SUMP LOCATION
WELL LOCATION

NOTE:
1. ALL SHALE ELEVATIONS WERE BASED ON GEOLOGICAL DATA DRAWINGS FROM A&M ENGINEERING AND ENVIRONMENTAL SERVICES, INC. DATED 5-8-1997, FIGURES 4-17 THRU 4-22.
2. DEPTHS SHOWN IN LEGEND ONLY REFLECT FROM EXISTING ELEVATION TO TOP OF SHALE LAYER. EXCAVATION WILL BE AN ADDITIONAL 4-5 INCH KEY INTO THE WEATHERED SHALE LAYER.
3. WHERE NO DATA WAS GIVEN OPERATOR WILL EXCAVATE UNTIL SHALE LAYER IS REACHED AND AN ADDITIONAL 4-5 INCH DEPTH FOR KEY INTO THE WEATHERED SHALE LAYER.
4. EXISTING ELEVATIONS WILL CHANGE TO ALLOW KEY INTO WEATHERED SHALE LAYER.

Scale: 1" = 120'
0' 60' 120'

NOTE:
PDF FILES ARE NOT ACCURATLY SCALED. FINAL PAPER COPY WILL BE SCALED CORRECTLY.

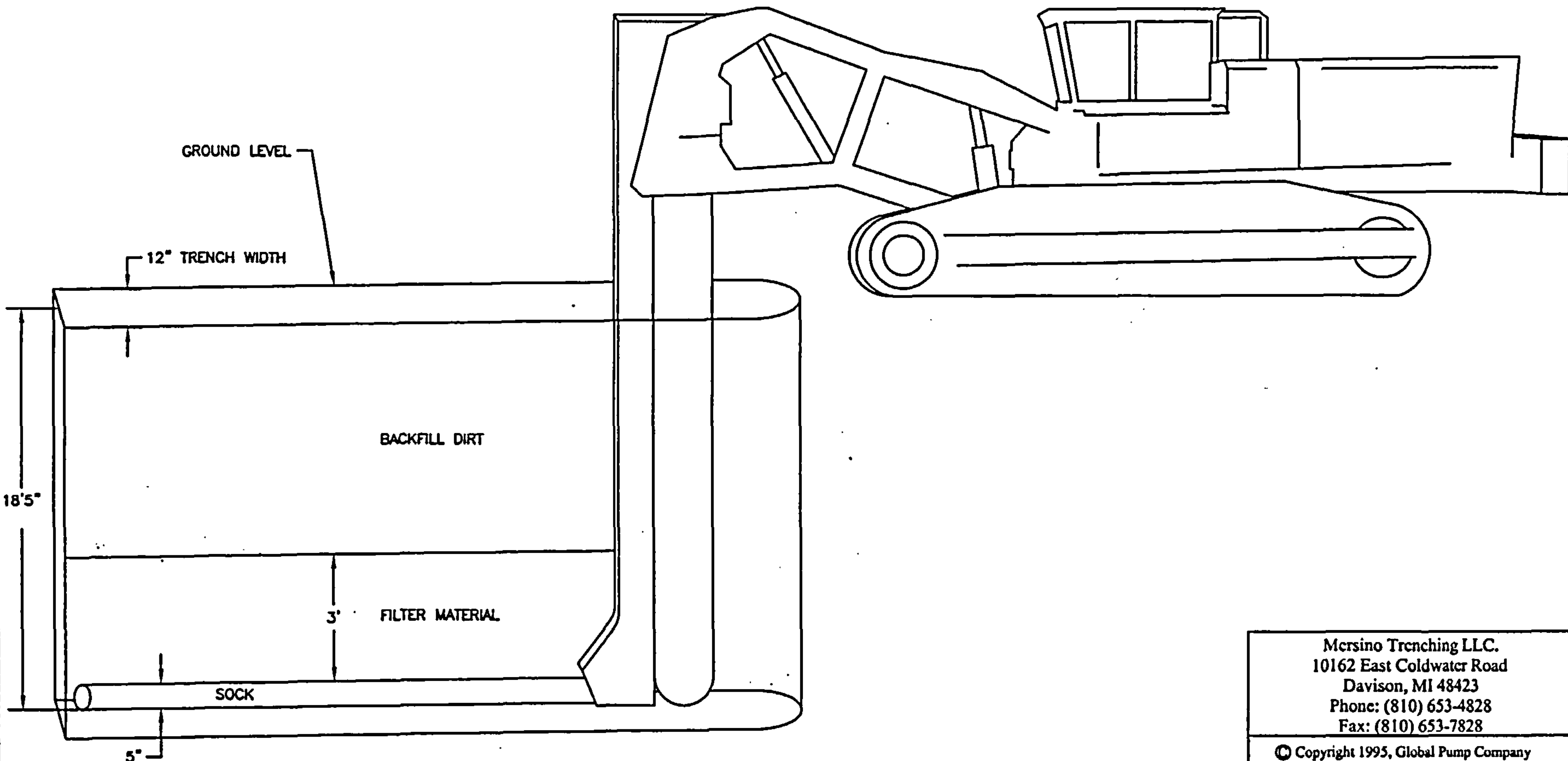
RECON
Remedial Construction Services, L.P.
9720 Derrington
Houston, TX 77064
Phone: (281)955-2442 Fax: (281)890-5172
www.recon-net.com

TITLE
DEWATERING TRENCH
STATIONS AND DEPTHS
KAISER ALUMINUM
Tulsa, Oklahoma

Revisions

No.	By	Description	Date

Figure 2



Mersino Trenching LLC.
10162 East Coldwater Road
Davison, MI 48423
Phone: (810) 653-4828
Fax: (810) 653-7828

Title: **Trencher**

SIZE	FSCM NO.	DWG NO.	REV
C		XXXX	–
SCALE NTS		SHEET 1 of 1	

US Ecology Transportation Work Plan

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: 01

EFFECTIVE DATE: MAY 2004

Approved, Bill Vinzant
J. W. (Bill) Vinzant – Project Manager

5-10-04
Date

Kaiser Aluminum & Chemical Corporation

US Ecology Transportation Work Plan

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **01**

EFFECTIVE DATE: **MAY 2004**

5/7/04 5/7/04

Danny P. Brown – Project Manager / Date

Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

TRANSPORTATION PLAN WORK PLAN

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I. DEFINITIONS

A_2 Quantity(49 CFR 173.403): The maximum activity of radioactive material, other than special form or low specific activity (LSA) radioactive material, permitted in a Type A package. See Title 49 CFR 173.435 of Reference 10.

Bulk Packaging(49 CFR 171.8): Packaging other than a vessel or barge, including a transport vehicle or freight container, in which hazardous materials are loaded with no intermediate form of containment and which has:

- A maximum capacity greater than 450 K (119 gallons) as a receptacle for a liquid;
- A maximum net mass greater than 400 kg (882 pounds) or a maximum capacity greater than 450 L (119 gallons) as a receptacle for a solid; or
- A water capacity greater than 454 kg (1000 pounds) as a receptacle for a gas as defined in 49 CFR 173.115.

Carrier: The carrier is an individual or organization engaged in the business of transporting property. Private carriers are carriers who transport their own materials. Contract Carriers are carriers who carry goods for the general public under a specific contract between the shipper and the carrier. Common Carriers are carriers that transport goods under the control of the Interstate Commerce Commission. Transportation regulations for radioactive material are applicable to all three classes of carriers.

Closed Transport Vehicle (49 CFR 173.403): A vehicle equipped with a securely attached exterior enclosure that during normal transportation restricts the access of unauthorized persons to the cargo space containing the radioactive material. The enclosure may be either temporary or permanent, and in the case of packaged materials may be of the see through type and must limit access from top, sides, and ends.

Consignee: The consignee is the individual or organization to whom the shipment is made. For radioactive shipments, the consignee must possess the necessary licenses for possession of the radioactive material.

Empty Packaging (49 CFR 173.428): A package that previously contained Class 7 (radioactive) materials and has been emptied of contents as far as practicable.

Exclusive Use (49 CFR 173.403): The sole use of a conveyance by a single consignor and for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee. The consignor and the carrier must ensure that any loading or unloading is performed by personnel having radiological training and resources appropriate for safe handling of the consignment. The consignor must issue specific instructions, in writing, for the maintenance of exclusive use shipment controls, and include them with the shipping paper information provided to the carrier by the consignor.

Hazardous Material (49 CFR 171.8): Is any substance or material, including a hazardous substance, which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated.

Hazardous Substance (49 CFR 171.8): Is any material, including its mixtures and solutions, that:

- Is listed in the Appendix to 49 CFR 172.101;
- Is in a quantity, in one package, which equals or exceeds the reportable quantity (RQ) listed in the Appendix to 49 CFR 172.101, and when in a mixture or solution for radionuclides, equals or exceeds unity when all nuclides are placed in a unity equation. For other than radionuclides, is in a concentration by weight which equals or exceeds the concentration corresponding to the RQ of the material, as shown in the following table:

RQ		CONCENTRATION BY WEIGHT	
POUNDS	KILOGRAMS	PERCENT	PPM
5000	2270	10	100,000
1000	454	2	20,000
100	45.4	0.2	2,000
10	4.54	0.02	200
1	0.454	0.002	20

Hazardous Waste (49 CFR 171.8): Any material that is subject to the Hazardous Waste Manifest Requirements of the U.S. Environmental Protection Agency specified in 40 CFR Part 262.

Hazmat Employee (49 CFR 171.8) means a person who is employed by a hazmat employer and who in the course of employment directly affects hazardous materials transportation safety. This term includes an owner-operator of a motor vehicle, which transports hazardous materials in commerce. This term includes an individual, including a self-employed individual, employed by a hazmat employer who, during the course of employment:

- Loads, unloads, or handles hazardous materials;
- Tests, reconditions, repairs, modifies, marks, or otherwise represents containers, drums, or packagings as qualified for use in the transportation of hazardous materials;
- Prepares hazardous materials for transportation;
- Is responsible for safety of transporting hazardous materials; or
- Operates a vehicle used to transport hazardous materials.

Hazmat employer (49 CFR 171.8) means a person who uses one or more of its employees in connection with: transporting hazardous materials in commerce; causing hazardous materials to be transported or shipped in commerce; or representing, marking, certifying, selling, offering, reconditioning, testing, repairing, or modifying containers, drums, or packagings as qualified for use in the transportation of hazardous materials. This term includes an owner operator of a motor vehicle, which transports hazardous materials in commerce. This term also includes any department, agency, or instrumentality of the United States, a State, a political subdivision of a State, or an Indian tribe engaging in an activity described in the first sentence of this definition.

Limited quantity of Class 7 (radioactive) material (49 CFR 173.403) means a quantity of radioactive material not exceeding the materials package limits specified in 49 CFR 173.425 and which conform with requirements specified in 49 CFR 173.421.

Low specific activity material (LSA) (49 CFR 173.403) means Class 7 (radioactive) material with limited specific activity, which satisfies the descriptions and limits set forth below. Shielding materials surrounding the LSA material may not be considered in determining the specific activity of the contents. LSA material must be in one of three groups:

<u>LSA-I</u>

- Ores containing only naturally occurring radionuclides and uranium and thorium concentrates of such ores; or
- Solid unirradiated U-Nat, or U-dep or Th-nat or their solid or liquid compounds or mixtures; or
- Radioactive material with an unlimited A2 value (does not include fissile material); or

- Mill tailings, contaminated earth, concrete, rubble, other debris, and activated material in which the radioactive material is uniformly distributed and the average specific activity does not exceed 1 E-6 A2/g.

LSA-II

- Water with tritium concentration up to 740 GBq/liter (20.0 Ci/liter); or
- Materials in which the radioactive material is distributed throughout and the average specific activity does not exceed 1E-4 A2/g for solids and gases or 1E-5 A2/g for liquids.

LSA-III

Solids (consolidated wastes, activated materials) that meet the requirements of 49 CFR 173.468 and in which:

- The radioactive material is distributed throughout a solid or collection of solid objects, or is distributed throughout in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.);
- The radioactive material is relatively insoluble, or is intrinsically contained in a relatively insoluble material, so that, even under the loss of packaging, the loss of radioactive material, when placed in water for 7 days would not exceed 0.1 A2; and
- The average specific activity of the solid does not exceed 2E-3 A2/g.

Low Toxicity Alpha Emitters (49 CFR 173.403) are:

- U-nat, U-dep, Th-nat;
- Ores, concentrates or tailings containing U-235, U-238, Th-232, Th-228 and Th-230; or
- Alpha emitters with a half-life of less than 10 days.

Marking (49 CFR 171.8) means a descriptive name, identification number, instructions, cautions, weight, specification, or UN marks, or combinations thereof, required by Part 172 Subpart D of 49 CFR on outer packagings of hazardous materials.

Natural thorium (49 CFR 173.403) means thorium with the naturally occurring distribution of thorium isotopes (essentially 100 weight percent thorium-232).

Non-fixed radioactive contamination (49 CFR 173.403) means radioactive contamination that can be readily removed from a surface by wiping with an absorbent material. Non fixed (removable) radioactive contamination is not significant if it does not exceed the limits specified in 49 CFR 173.443.

Non-bulk packaging (49 CFR 171.8) means a packaging, which has:

- A maximum capacity of 450 L (119 gallons) or less as a receptacle for a liquid;
- A maximum net mass of 400 kg (882 pounds) or less and a maximum capacity of 450 L (119 gallons) or less as a receptacle for a solid; or
- A water capacity of 454 kg (1000 pounds) or less as a receptacle for a gas as defined in 49 CFR 173.115.

Normal form radioactive material (49 CFR 173.403) means radioactive material, which has not been demonstrated to qualify as special form radioactive material.

Package (49 CFR 173.403) means, for Class 7 (radioactive) material, the packaging together with its radioactive contents as presented for transport.

- Excepted Package means a packaging together with its excepted Class 7 (radioactive) materials as specified in 49 CFR 173.421-173.426, and 173.428.
- Type A Package means a packaging that, together with its contents limited to A1 or A2 as appropriate, meets the requirements of 49 CFR 173.410 and 173.412 and is designed to retain the integrity of containment and shielding required by 49 CFR 173 under normal conditions of transport as demonstrated by the tests in 49 CFR 173.465 or 173.466 as appropriate. A Type A package does not require Competent Authority Approval.

Packaging (49 CFR 173.403) means, for radioactive materials, the assembly of components necessary to ensure compliance with the packaging requirements of 49 CFR 173. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and service equipment for filling, emptying, venting, and pressure relief, and devices for cooling or absorbing mechanical shocks. The conveyance, tie down system, and auxiliary equipment may sometimes be designated as part of the packaging.

Radioactive contents (49 CFR 173.403) means the radioactive material, together with any contaminated liquids or gases, within the package.

Radioactive material (49 CFR 173.403) means any material having a specific activity greater than 70 Bq/g (0.002 microcuries per gram ((Ci/g).

Radioactive Waste means, for the purposes of this procedure, radioactive materials that are being transferred to a disposal facility or to a processing facility that forwards the radioactive materials to disposal.

Specific activity (49 CFR 173.403) of a radionuclide means the activity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the activity per unit mass of the material.

Strong Tight Container (49 CFR 173.427) means, for this procedure, a container that will have no leakage of radioactive material under conditions normally incident to transportation.

II. Transportation Work Plan

1.0 SCOPE:

The purpose of this plan is to establish guidance to properly describe, package, mark, label, load, inspect and manifest radioactive and/or hazardous materials for transportation from the Kaiser – Tulsa Facility to the US Ecology, Simco and Grand View, Idaho facilities for waste transfer and disposal in accordance with the applicable regulatory requirements.

This plan applies to all project related, US Ecology Hazardous or Radioactive Materials waste shipments by rail from the Kaiser – Tulsa facility to US Ecology's Simco, Idaho waste transfer facility. This plan has been designed to satisfy DOT regulatory and US Ecology waste acceptance requirements for the types of shipments anticipated to be performed by US Ecology for this project. This plan may be amended as necessary to satisfy changes to project scope, and regulatory or disposal site requirements.

US Ecology shipment of regulated radioactive materials by highway or by a proper shipping name not initially addressed by this plan may be accomplished by utilizing US Ecology approved NARM Services Brokerage Procedures

1.1 Site Location

The Kaiser - Tulsa Facility is located at 7311 East 41st Street in Tulsa, Oklahoma.

1.2 Brief Site History

Site history is detailed in Reference 1.

2.0 PREREQUISITES

2.1 RESPONSIBILITIES

All personnel involved in the shipment of radioactive or hazardous material or with processing the documentation generated by such shipments are responsible to the USE Transportation Manager for compliance with this Plan.

Management responsibilities as related to radioactive or hazardous material shipments are as follows:

2.1.1 Ensuring personnel who are packaging, marking, labeling, shipping or certifying the radioactive and/or hazardous materials for shipment are trained in accordance with Reference 6, Subpart H.

2.1.2 Maintaining an updated and approved Transportation Plan

2.1.3 Reviewing shipment manifests and related documentation

2.1.4 Ensuring compliance to plan requirements and DOT regulations

2.1.5 2.1.5 USEI will take title to the waste material when management authorizes gondolas to depart Kaiser's gate destined for Grand View, Idaho

Additional responsibilities are as follows:

2.1.6 Personnel involved with the shipment of radioactive and/or hazardous material or with processing the documentation generated by such shipment shall be trained in accordance with this plan and applicable sections of Reference 6.

2.1.7 Personnel performing shipment(s) of radioactive materials, in accordance with this plan, may also be responsible for performing, documenting, and reviewing package or vehicle radiation and contamination surveys and assuring compliance with the contamination and radiation limits specified in Reference 6, specifically 49 CFR 173.441 and 173.443.

2.2 SAFETY PRECAUTIONS

2.2.1 All transportation related operations shall comply with the site health and safety requirements of References 2 and 3 and effective Safety Work Permit(s) (SWP's) for the work being performed.

2.2.2 Ensure that proper eye, ear, face, head, and footwear are worn by all personnel handling radioactive material consistent with the operational and environmental conditions present. Safety glasses shall be worn when surveying or inspecting under vehicles and railcars.

2.2.3 All injuries will be reported to the responsible supervisor and/or project manager immediately.

2.2.4 Normally all radioactive materials packages will be handled by mechanical means to reduce potential exposures.

2.2.5 When working around loading and lifting equipment, all individuals involved in the loading shall wear steel-toed footwear and be alert to the movement of loading and other equipment.

2.2.6 When handling radioactive materials, individuals should be aware of the radiation dose rates expected to maintain exposures as low as reasonably achievable (ALARA).

3.0 WASTE DESCRIPTION

3.1 Contaminants of Concern

The areas and materials to be remediated are described in Reference 1 as soils, building materials, and debris contaminated with low levels of process residue. Specifically, the material contains the following known contaminates of concern:

- Natural Thorium (Th-232, Th-228)
- Thorium 230

3.2 Volumes

It is anticipated that approximately 50,000 tons of excavated material will be loaded into gondola railcars and transported offsite for ultimate disposal at USE / Grand View. It is estimated that approximately 500 rail cars of material will be shipped for disposal.

3.3 Disposal Facility Limits

3.3.1 The US Ecology, Grand View disposal facility waste acceptance criteria are specified in Reference 9. The specific radiological limits, considering the contaminants of concern, ***when averaged over each railcar are:***

- Total specific activity < 2000 pCi/g
- <0.05% by weight Source Material (Thorium) (%Th-232 + %Th-228 +%Th-230)

4.0 CHARACTERIZATION CERTIFICATION REQUIREMENTS

Waste materials shall be characterized in accordance with applicable project plans or procedures and approved by US Ecology prior to shipment. A data package containing Batch Characterization Analysis for each railcar or group of railcars shall be prepared by qualified personnel and provided to the Transportation Manager for evaluation against disposal site waste acceptance criteria. This data may include:

- Batch radiological concentrations per nuclide
- Batch ID number(s)
- Batch gross weight and railcar distribution
- Railcar radiological survey information for US Ecology MicroShield concentration estimates

5.0 TRANSPORTATION

This plan applies to US Ecology railcar waste shipments from the Kaiser – Tulsa facility to the US Ecology, Simco, Idaho waste transfer facility. Shipments to other disposal sites and/or processing facilities are beyond the scope of this plan and may be subject to specific additional requirements referenced and/or provided by the receiving facility.

5.1 General Requirements for US Ecology Radioactive and\or Hazardous Material Shipments

5.1.1 *Pre-Shipment Considerations*

The Transportation Manager shall communicate the need for special packaging instructions including pre-treatment steps required prior to packaging (cutting/drying/draining), how to line the railcar, type and quantity of absorbent, etc.

USE shall verify that the railcar is in satisfactory condition, the liner is securely sealed and the closure device, if any, is correctly applied prior to shipment.

USE will ensure each railcar has been marked, labeled and/or placarded in accordance with Sections 5.7 & 5.8 of this procedure.

SITE RADIATION TECHNICIANS shall perform radiological and contamination surveys to determine, at a minimum, exterior surface contamination levels and the maximum radiation levels on contact with the railcar surface. These surveys shall be documented and reviewed prior to shipment approval.

The Transportation Manager, in consultation with project management, shall schedule railcar pickup and delivery as necessary to support project schedule and needs.

5.2 Waste Characterization / Classification

5.2.1 Waste characterization and classification is fundamental to proper waste management and disposal. It supports both regulatory compliance with DOT, EPA, and NRC Regulations and is necessary to properly transport radioactive and\or hazardous materials. Correct identification and classification is the most important function under the regulations because this determination will establish all other requirements for packaging, marking, labeling, placarding, documentation, carrier requirements and shipment controls. It will also determine what response actions are taken by a first responder in the event of an incident during transportation. With technical grade material, classification will generally be less time and labor intensive and will be as simple as locating the material in the Hazardous Material Table (49 CFR 172.101), contained in Reference 6 and using the hazard class designated there. With materials containing mixtures of two or more hazardous materials, and especially if it is a hazardous waste, this process will require considerably more effort. References 5, 6 and 7 identify appropriate shipping classes and whether adherence to specific air and water regulation is necessary for these types of shipments.

5.2.2 Waste Characterization is the process of determining the radiological and\or hazardous constituents representative of a waste stream or waste material. Thorough sampling of an area or media is necessary in determining the radiological and hazardous characteristics of the materials. The following are methods that can be used to support the characterization process

- Scaling factors derived through historical process/site information
- Customer and historical site Information
- Material Safety Data Sheets (MSDS) and /or procurement information that lists chemical purchases
- Radiological surveys/testing
- Chemical and physical characteristics from past or current sampling events

5.2.3 Initial visual characterization is performed during surveys, site evaluation, and walk downs. Profile development for disposal requires a closer evaluation and sampling of waste to be generated. Suspected hazardous wastes will be sampled if necessary to verify RCRA Hazardous Wastes characteristics. Waste lead is an example of a hazardous waste that does not require verification testing. Block, brick and building materials are an example of materials that do not typically require sampling to verify as a non hazardous waste. Coatings and residual spill material on surfaces may require testing if historical/owner information is not available to make the hazardous/non-hazardous determination.

5.2.4 The scope of this plan is currently limited to the post-characterization, post-classification of materials and delineates the requirements to be followed by qualified project shippers. Project specific characterization procedures may be used to supplement this transportation plan as required.

5.2.5 All materials will be compared and classified according to the applicable sections of References 5, 6 and 9.

5.3 Burial Classification

5.3.1 Each burial site has issued specific permit or license limits for wastes accepted for treatment or disposal. Additionally, burial sites operating under an NRC Part 61 program, or equivalent, require disposal packages to be classified and marked prior to shipment to the respected facility. Waste classification for licensed disposal, if required, will be performed by qualified personnel utilizing project specific or US Ecology approved waste brokerage procedures The issues relative to radioactive waste and disposal classification are independent from the DOT packaging and shipment requirements.

5.4 Shipment Preparation

5.4.1 Preparation for shipment is divided into two major steps. The first step is the selection of the proper shipping name and packaging for the hazardous and\or radioactive material. The second step is to appropriately inspect, load, mark, label, placard and prepare documentation for transportation.

NOTE

All hazardous materials packages must meet the general packaging requirements of Reference 6 (49 CFR 173.24). Additional packaging requirements are contained within and determined by the applicable regulations used for each shipment of such materials.

5.4.2 Domestic Regulations regarding shipping are found as references in this procedure pertaining to DOT, EPA and NRC Regulations. These regulatory references are the key to navigating through the various regulations that may be used to complete a radioactive and\or hazardous materials shipment.

5.4.3 Domestic transportation regulations are updated frequently. Changes to the regulations will be tracked carefully and this plan revised accordingly to ensure compliance.

5.5 Determination Of Proper Shipping Name

The following proper shipping name determination is based on the only constituents of concern being the radioactivity or radionuclides present in the waste materials at their maximum allowed specific activity and estimated minimum gondola net weight. Subsequent proper shipping name determinations may be necessary if other hazardous constituents are determined to be present in the materials to be shipped

Using the following specific activity limits for Grand View disposal:

Nuclide	specific activity	RQ	Container activity (95 tons)
Th-232	55 pCi/g	1.0 mCi	4.74 mCi
Th-228	55 pCi/g	10 mCi	4.74 mCi
OR			
Th-nat	110 pCi/g	11 mCi	9.49 mCi
AND			
Th-230	193 pCi/g	10 mCi	16.6 mCi
	Total specific activity	775 pCi/g (28.7 Bq/g)	

Under Current DOT Regulations:

Since total specific activity is less than 70 Bq/g (approximately 2000 pCi/g), the material does not meet the definition of a radioactive material and therefore is not subject to Class 7 shipping requirements.

***RQ Determination*:**

Using the unity rule to calculate the total RQ value:

(Th-230 / RQ value + Th-Nat / RQ value) = (16.6/10) + (9.49/11) = 2.52

Since unity equals or exceeds 1.0, the material qualifies as a hazardous substance and therefore is considered as a hazardous material and reportable quantity for transportation purposes (see definitions in 49CFR 171.8).

49 CFR 172.800 security plan requirements will also apply if shipments are required to bear Class 9 placarding or are made in certain bulk packaging.

Proper shipping name:

Environmentally hazardous substances, solid, n.o.s, 9, UN3077, PG III, RQ (Th-Nat, Th-230)

Upon Implementation of HM-230

HM-230 requirements must be implemented no later than 10/1/04. Voluntary compliance is authorized as of 2/25/04. It is anticipated that the shipping to be performed under this plan will be complete prior to the required implementation date for HM-230. If it becomes apparent that the shipping period may extend beyond 10/1/04, then this plan will be revised to incorporate appropriate Class 7 shipping requirements by the required implementation date.

Nuclide	Exempt Concentration Limits	A2 value	LQ limit	LSA-1 limit
Th-232	270 pCi/g	Unlimited	Unlimited	Unlimited
Th-228	27 pCi/g	27 mCi	0.027 mCi	810 pCi/g
Th-Nat	27 pCi/g	Unlimited	Unlimited	Unlimited
Th-230	27 pCi/g	27 mCi	0.027 mCi	810 pCi/g

Exempt concentration (and exempt consignment) limits are exceeded, therefore transportation of this material is subject to Class 7 shipping requirements. 49CFR173.425 limits are exceeded; therefore the materials may not be shipped under limited quantity provisions. The specific activities are within the LSA-1 limits and the material meets the definition (49 CFR 173.403) of LSA-1.

Proper shipping name:

Radioactive Material, LSA, n.o.s., 7, UN2912, RQ (Th-Nat, Th-230)

5.6 Packaging and Inspection

5.6.1 The transportation packaging selected for this project consists of sealable super load wrappers contained in gondola style railcars. This configuration meets the "open top, sift proof rail car" requirement, as authorized by special provision B54 of 172.102, for transport of **Environmentally hazardous substances, solid, n.o.s.** This packaging will also satisfy the "bulk packaging and strong tight packaging" requirements for transport of Radioactive LSA-I as required by 173.427(c) if necessary.

5.6.2 All packages (railcars) shall meet the general requirements of Reference 6. Prior to loading, each railcar shall be visually inspected to confirm that it is rail worthy and no damage has occurred that would allow release of radioactive materials.

5.6.3 Check that the package or load wrapper has been properly closed and sealed prior to release for shipment.

5.6.4 Railcars containing materials that are moist or damp shall have sufficient absorbents added to sorb any free liquids released during transport. USE shall perform visual moisture inspections during railcar loading.

5.7 Markings

5.7.1 *Bulk Packages (49 CFR 172.302, 304, 310, 322, 331, 332, 334, 336 and 338)*

5.7.1.1 For "**Environmentally hazardous substances, solid, n.o.s**", each railcar must be marked with the ID number (3077) as specified in 173.332 or 173.504(f)(9).

5.8 Labeling and Placarding

5.8.1 Bulk Packages: Labeling (49 CFR 172.400 and 400a)

5.8.1.1 DOT specification labeling is not required for bulk packaging with a volume of greater than 640 cubic feet (172.400(a)(2)). The load wrapper and gondola railcar bulk packaging configuration being utilized on this project has a volume in excess 640 cubic feet.

5.8.2 Placarding (49 CFR 172.500)

5.2.8.1 Class 9 placarding is not required (172.504(f)(9)). If railcars are placarded, this placarding must meet the requirements of 172.508, 514, 516, 519 and 560.

5.9 Package Radiation and Contamination Surveys

5.9.1 Removable contamination surveys will be performed by SITE RADIATION TECHNICIANS on each outbound railcar in accordance with on site procedures. Administrative levels for removable contamination are 1000 dpm/100 cm2 beta-gamma and 200-dpm/100 cm2 alpha. Railcars with removable contamination above the administrative levels will not be shipped.

5.9.2 Outbound railcar radiation surveys will be performed in accordance with onsite procedures. No railcar with contact radiation levels exceeding 500 microR/hr will be shipped without the specific approval of the Transportation Manager and the disposal facility Waste Approval Manager (Simco receipt requirement).

5.10 Loading procedure

5.10.1 Inspect the physical integrity of railcar and remove any materials or items that could affect the proper installation of or cause damage to the super load wrapper during loading or transport. Upon completion of this inspection, the railcar may be released to RECON for liner installation and loading.

5.10.2 USE and RECON will evaluate the analytical results for the materials to be loaded and agree on a basic loading plan that will provide assurance, to the extent practical, that the loaded materials are essentially homogenous and that the average and maximum (hot spots) concentration of radionuclides do not exceed the disposal facility acceptance criteria.

5.10.3 RECON and USE personnel shall inspect the waste materials during and upon completion of loading to verify that the materials are consistent with the description on the approved waste profile form and that there are no free liquids present. Free liquids shall be solidified, sorbed or removed from the shipping container prior to release.

5.10.4 Upon completion of loading, US Ecology shall perform a Simco pre-receipt railcar radiation survey to obtain data for a comparison of reported average and maximum specific activities to the estimated average specific and maximum activities calculated based on observed radiation levels.

5.10.5 Upon completion of the final waste inspection and approval of the Transportation Manager, the load wrapper may be sealed in preparation for shipment. The load wrapper may be temporarily closed prior to completion of loading during inclement weather or as necessary to support project work schedules.

5.11 Shipment Documentation and Scheduling

5.11.1 Shipping papers are documents or combination of documents containing the information required in Subpart C of Reference 6. (49 CFR 172.200). A rail bill of lading and the individual Non-Hazardous Waste Manifests will be utilized as the shipping papers for this project. These documents will contain, at a minimum, all of the information required by 172.200 and the applicable emergency response information required by 172.600.

5.11.2 A Non Hazardous Waste Manifest shall be prepared for each railcar of material being shipped to the Simco facility. A rail Bill of Lading shall be prepared for each group of railcars comprising a shipment from the Tulsa facility.

5.11.3 The Transportation Manager shall coordinate with the US Ecology Corporate Transportation Manager and the local or central office railroad personnel to obtain transporter signatures and schedule rail shipments. The Transportation Manager will also forward completed Non-Hazardous Waste Manifests to the Grand View facility.

5.11.4 The US Ecology Corporate Transportation Manager will track railcar status on a daily basis and provide shipment update reports to the project Transportation Manager.

5.12 Transportation Security Plan Requirements

5.12.1 49 CFR 172.800(b)(4) requires that a security plan for hazardous materials be developed and adhered to by each person who offers for transport "a shipment of a quantity of hazardous materials in a bulk packaging having a capacity equal to or greater than (3,500 gallons) for liquids or (468 cubic feet) for solids."

5.12.2 A project specific risk assessment will be performed and a security plan, which meets the requirements of 172.802, will be developed and implemented prior to the commencement of transportation related hazardous materials handling.

6.0 TRAINING

6.1 All Hazmat employees shall receive the general and function specific D.O.T Hazardous Materials training as specified in 49 CFR 172.700-704 prior to commencement of their transportation related hazardous materials handling.

6.2 All Hazmat Employees shall successfully complete testing on the subject matter provided in the training described in Section 6.1. Evidence of successful completion of this testing shall be included with the employee Hazmat training records required by 172.704(d).

6.3 Per 172.704(C)(3), "Relevant training received from a previous employer or other source may be used to satisfy the requirements of this subpart provided a current record of training is obtained from the hazmat employees' previous employer". If utilized, evidence of this current (within three years) relevant training must be maintained in the employee's Hazmat training record.

6.4 Security awareness training and Security Plan Implementation training shall be provided to all project employees within 90 days of hire. All initial project hazmat employees shall receive this training prior to commencement of transportation related hazardous materials handling.

III. REFERENCES

1. Kaiser Aluminum and Chemical Corp. Decommissioning Plan, Tulsa Facility, Tulsa, Ok.
2. RECON Environmental Health and Safety Plan
3. RECON Radiation Health and Safety Plan
4. 10 CFR Part 20, "Standards for Protection Against Radiation"
5. 40 CFR Parts 260-299, "EPA Regulations for Hazardous Wastes"
6. 49 CFR Parts 100-185, "Transportation"
7. 49 CFR Parts 393, " Parts and Accessories Necessary for Safe Operation"
8. 2000 Emergency Response Guidebook (ERG 2000), Department of Transportation
9. US Ecology Idaho, Grand View, Idaho Disposal Facility Waste Acceptance Criteria

Conveyor Mounted Radiation System Work Plan

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: 01

EFFECTIVE DATE: MAY 2004

Approved, Bill Vinzant
J.W. (Bill) Vinzant – Project Manager

5-10-04
Date

Kaiser Aluminum & Chemical Corporation

Conveyor Mounted Radiation System Work Plan

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **01**

EFFECTIVE DATE: **MAY 2004**

5/7/04
Danny P. Brown – Project Manager / Date

5/7/04
Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

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Acronyms:

Acronym	Description
cps	Counts per Second
$DCGL_{EMC}$	Derived Concentration Guideline Level – Elevated Measurement Comparison
$DCGL_{W}$	Derived Concentration Guideline Level - Wilcoxon Rank Sum
DOE	Department of Energy
DP	Decommissioning Plan
Kaiser	Kaiser Aluminum and Chemical Corporation
MCA	Multi-Channel Analyzer
NaI	Sodium Iodide
NASVD	Noise Adjusted Single Value Decomposition
NIST	National Institute for Standards and Technology
NRC	Nuclear Regulatory Commission
RCT	Radiological Control Technician
RECON	Remedial Construction Services, L.P.
SMC	Standard Magnesium Corporation
SMCM	Sub-Surface Multi-Spectral Contamination Monitor
SRA	Shonka Research Associates

1. PREFACE

The Shonka Research Associates, Inc. (SRA) conveyor mounted radiation system work plan involves three items.

- Setup, operate and maintain a radiation system mounted over a conveyor.
- Summarize the data collected from the radiation detection system mounted over the conveyor for a paper report handed to Remedial Construction Services, L.P. (RECON).
- Setup, operate and maintain additional radiation detector systems used for waste characterization.

2. BACKGROUND

The Kaiser Aluminum & Chemical Corporation (Kaiser) plant in Tulsa, Oklahoma was built by the Standard Magnesium Corporation (SMC) in the early to mid-1950s to manufacture magnesium products. Kaiser purchased the facility in 1964.

The Kaiser facility is located at 7311 East 41st Street in Tulsa, Oklahoma. It is situated in Tulsa County, Oklahoma, about 5 miles southeast of the downtown center of the city of Tulsa. An approximate 14-acre pond parcel north of the railroad contains a retention pond, the flux building, a former freshwater pond area, and a segment of Fulton Creek. The remediation area is bounded by the south fence line, the freshwater pond embankment on the west, Fulton Creek ditch on the north, the east fence line, and the northern and western edges of the flux building and paved area. The areas to be remediated include a portion of the 4-acre operational area south of the railroad, and a large portion of the 14-acre pond parcel located north of the railroad. The pond parcel is divided into three parts--the non-impacted former freshwater pond to the west 4 acres, the affected retention pond/reserve pond area to the east approximately 9 acres, and the area containing the flux building and paved area approximately 1 acre.

3. INTRODUCTION

RECON will utilize a system of conveyors and radiation monitors to sort the soil and dross (material) and to document that the material is below the limits dictated in the facility Decommissioning Plan (DP) filed with the Nuclear Regulatory Commission (NRC) and is ready for the Final Status Sampling (FSS) Survey. Radiation characterization tools will be utilized and include: walk-over monitors and excavator bucket monitor. SRA was contracted to build and operate radiation monitors or systems.

SRA utilizes a system called the Subsurface Multi-spectral Contamination Monitor (SMCM), which was developed with funding from the NRC (NRC-04-92-096. "Continued Development of a High Sensitivity Landfill Monitor: The Results of a Phase II SBIR Grant". December, 1994). SMCM combines into one instrument the capabilities of both scanning (rolling) detection with *in situ* gamma spectrometry. The SMCM is a scanning spectrometer. The data is processed with Noise Adjusted Single Value Decomposition (NASVD) algorithms originally developed for sonar. This treatment of the data greatly reduces the statistical fluctuation normally encountered in scanning detection.

The SMCM controls the operational flow of the material to sort the raw material into 2 piles, On-Site Piles (O-Pile), < 31.1 pCi/g of Th-232 net or Landfill Piles (L-Pile) ≥ 31.1 pCi/g of Th-232 net. The established background level for the Thorium Remediation Project is 1.1 pCi/g. The SMCM sorting logic setpoint is 31.1 pCi/g of Th-232 net. The setpoint for the SMCM sorting logic may vary during the sorting operations if necessary.

The O-Piles will be used as onsite backfill. The L-Piles will be transported to US Ecology Inc., Simco, Idaho (Waste Transfer Facility) with final disposal at US Ecology, Inc Grandview Operations Facility, Grandview, Idaho.

The SMCM system will be operated with alarm setpoints. The raw material flow is controlled by the RECON excavator operator. The SMCM will control diversion parts of the conveyor system.

4. METHODOLOGY

4.1 The Conveyor Mounted SMCM

The SMCM utilizes a radiation detection system that is a fixed platform mounted over a conveyor. The Thorium Remediation Project will make use of a single thallium-doped sodium iodide (NaI (Tl)) detector. Spectra in a pre-defined energy range will be collected successively over a fixed time via a Multi-Channel Analyzer (MCA).

The detector will be placed into a protective enclosure. The detector will have thermal protection for temperature stabilization and will be shielded to reduce the radiation background as well as reducing any variability from changes in background due to radon in air, moving vehicles, and changes in nearby material. A trailer will be used as a mobile command center for the SMCM electronics and the process computer system.

Prior to deployment, the detector will be calibrated. Appropriate calculations will be performed to establish a calibration in an equivalent manner to the method of Helfer and Miller: "Calibration factors for Ge Detectors used for Field Spectrometry (*Health Physics* Vol. 55 No.1 (July), pp 15-29 1988).

The SMCM includes a sensor to verify that the conveyor speed is 250 fpm (feet per minute). The sensor is monitored (and the conveyor speed is calculated) during data collection.

The SMCM is equipped with a level switch to verify the material depth.

All measurements will be recorded to the process computer's hard drive and backed up on a CD. The SMCM operator controls the starting and stopping of the recorded data. All the recorded data between the starting of the recorded data and stopping of the recorded data is called a "survey strip." Data collected when the belt is stationary or with no material present is recorded but not reported.

The SMCM is equipped with a number of alarm enunciators. When material ≥31.1 pCi/g of Th-232 net is detected, the operation screen changes color. A remote day light readable monitor is available for the conveyor operator. The SMCM process computer activates a radiation diversion alarm light to the operator.

4.2 Establishment for Sorting Units

The raw material from the 9-acre pond parcel, the 3-acre area south of the railroad tracks and the area under the Flux Building define the excavation areas. The excavation area will have a grid system as shown in RECON's Work Plan, Figure WP B 2, to define the origin of materials.

4.3 Presorting Activities

Excavated material will be presorted prior to being separated by the Conveyor Mounted SMCM. The presort will be a rough cut for the purpose of providing a relatively consistent feed to the Conveyor Mounted SMCM. Material presorted as above 31.1 pCi/g of Th-232 net will be fed to the conveyor system separately from material presorted as below that criterion. Campaigning above and below criterion material separately will prevent the sorter from cycling excessively during operation. The bucket monitor described in Section 6.2 will be used to perform the presort. Decisions on which material will need to be disposed of off site and which material is suitable for backfill will be based on detailed data collected from the Conveyor Mounted SMCM as discussed in Section 4.4.

If the bucket monitor fails to perform as expected or becomes unavailable, hand-held meters or other methods will be used for the rough presort.

4.4 Performing the Sorting

RECON's excavator will place material on a vibrating screen to remove all debris and any material over 6 inches in diameter. The material that is less than 6 inches in diameter will pass thru the vibrating screen and will be carried to the Conveyor Mounted SMCM conveyor. Before it passes under the Conveyor Mounted SMCM, material will be leveled with a leveling bar placed across the conveyor to ensure that material is spread evenly across the conveyor belt and that only 6-8 inches of material will pass under the Conveyor Mounted SMCM. Once material is found to be either < 31.1 pCi/g of Th-232 net or ≥ 31.1 pCi/g of Th-232 net, it will fall into a pant leg chute. The SMCM sorting logic setpoint is a derated value from 31.1 pCi/g of Th-232 net. The Conveyor Mounted SMCM process computer will electronically control the gate inside the chute. Depending on the pCi/g, the material will fall onto one of two stacker conveyors creating an L-Pile or O-Pile described below.

Onsite Pile (O-Pile) - These raw materials will be sorted into piles of approximately 2000 ton sorting units (sorting units may vary and should not be considered a change to the plan). Note: The number of piles is based on the quantity of materials sorted with a value of < 31.1 pCi/g of Th-232 net. Material < 31.1 pCi/g of Th-232 net will be placed in piles with identification numbers such as; O-1, O-2, O-3, etc. Note: "O" – represents Onsite Pile, "1" representing an incrementing number based on the number of piles generated.

Landfill Pile (L-Pile) - These raw materials will then be sorted into piles of various ranges in pCi/g. Note: The number of piles and ranges selected to associate with those piles is based on the quantity of materials in various ranges of value of pCi/g in the L-Pile material. Material less than or equal to the derived concentration cut-off levels (ranges in pCi/g) will be placed in piles with naming conventions such as:

L-1-A	31.2pCi/g – 35 pCi/g of Th-232 net
L-1-B	35.1pCi/g – 45 pCi/g of Th-232 net
L-1-C	45.1pCi/g – 55 pCi/g of Th-232 net
L-1-D	55.1pCi/g – 100 pCi/g of Th-232 net

Note: "L" represents (L-Pile), "1" representing an incrementing number based on the number of L-Piles produced, and the "A", "B",- "Z", will represent the range of values of Th-232 pCi/g present. Depending on the actual materials encountered, the number of piles and ranges of activities will vary throughout the project. With this data the process computer creates a standardized pick list that will be utilized to create approximate 100 ton stockpiles <55 pCi/g for loading into railcars as described in Section 4.5.2. During the sorting for creating approximate 100 ton stockpiles, the pant leg chute will divert material under the direction of the SMCM computer if the stockpiled material will exceed 55 pCi/g averaged over a total of 100 tons. Diverted materials will be resorted with materials that will meet the offsite acceptance criteria (<55pCi/g).

All materials that have been scanned and placed into 100-ton piles will have a unique pile name as discussed above. For O-Piles, a number of piles may be treated as a sorting unit. For L-Piles there is only one pile that is equal to the sorting unit. Each L-Pile sorting unit is summarized in a Sorting Release Record Report that will accompany manifests for offsite material. Sorting release records will be generated upon request by the site management team members. A sample copy of the Sorting Release Record Report is located in Attachment No. 1.

4.5 Sorting Methods

The conveyor mounted SMCM collects data over a fixed time period as the material moves at 250 fpm (feet per minute). The collected data is termed an acquisition. During each acquisition, the process computer records the following: a spectra and live time from the MCA, the distance traveled, the average height of the material and the average density. Periodically during the operation, the operator records the system status information such as temperature in a field notebook or other means. Although all of these signals are collected and monitored during operations, the system's most important function is the real time low-level radiation alarms based on the data analysis. A brief description of the real time data analysis, alarms, and investigative measures is given below.

The spectra will be converted from units of counts to count per second (cps) by dividing by the live time. The net value in each region of interest is determined. The regions of interest of concern will be for potassium (K-40 @ 1461 keV), uranium (U-238 using Bi-214 @ 1764 keV), and thorium (Th-232 using Tl-208 @ 2614 keV). The monitoring of K-40 and U-238 helps assure the conveyor spectra is being recorded correctly when comparisons are made with the off-site lab as discussed in Section 5.1. A Cs-137 density gauge is used as described below. A source response check will be performed whenever the belt is empty.

The net Cs-137 is required for the density measurement and is calculated by removing the contribution to the Cs-137 region of interest from each of the primordials: K-40, U-238, and Th-232. To strip a spectrum (window) means to remove the contributions to an energy window from radionuclides emitting gammas of higher energies. Only a fraction of the emitted gamma photons register as full energy photons. Scattered photons originating from higher energy photons are measured in lower energy windows. The contribution from those scattered photons is removed when stripping the spectra.

4.5.1 On-Site (O-Pile) DCGLemc Diversion Alarms

Alarm logic drives the sorting mechanism. A moving window that averages the material on the conveyor belt will be set to divert material that is ≥ 31.1 pCi/g of Th-232 net.

4.5.2 Landfill (L-Pile) DCGLw Diversion Alarms

The conveyor will divert material if the average of a railcar will exceed 55 pCi/g averaged over a total of 100 tons. A pick list (a list that contains the various pCi/g levels in each L-Pile) will be provided for the heavy equipment loader operator so that the loads can be fed in a manner that ensures the 55 pCi/g is not exceeded. For example, alternating loads of 45 and 65 pCi/g materials should average 55 pCi/g and no material will be diverted as long as the 45 pCi/g hopper load is used first to start the averaging process. As the total reaches the 100-ton railcar load, the influence on the average from alternating higher range pCi/g materials and lower range pCi/g materials will diminish.

4.6 Quality Control

Quality control and quality assurance for the laboratory environment has been studied for some time and is well established in the nuclear industry for radiation detection equipment. However, quality control associated with the operation of radiation detector in the field is not generally established with the same degree of rigor. To attain lab-like stability in the field, rigorous quality control and quality assurance measures are required that go beyond common practice. The following text outlines the traditional quality control measures for gamma spectrometers when operated in a laboratory environment. The remaining controls that are imperative to proper field operation have been integrated into Section 4.7.
Prior to deploying, the NaI detector will be calibrated at SRA's laboratory in Marietta, Georgia. The MCAs will be aligned to ensure a linear relationship, with a zero offset, between channels and energy. The internal computer-controlled digital gain in all MCAs is adjusted to align 1461 keV (K-40 photo peak) into channel 250. This calibration (5.844 keV per channel with 512 channels or 0 to 3 MeV) is used in order to resolve the 2.614 keV photon from the Tl-208 daughter product in the Th-232 decay chain. The detector will be calibrated to determine their intrinsic efficiency by placing National Institute for Standards and Technology (NIST) traceable button sources, Co-60 (nominal 0.5 μCi) or Cs-137 (nominal 9.0 μCi), one meter below the front face of the detector.

During operation, source response checks will be performed at the beginning and end of each day and at least once during the day (typically every five hours throughout the day). The source response checks will be performed by recording data over a fixed time while check sources are present. The sources will be mounted to a removable source response check fixture, which is mounted to the detector enclosure. The sources used for the source response checks are not typically NIST traceable. The sources are only intended to act as a stable artifact and not as a means of calibration. The source response checks are the same checks performed with hand-held instruments. In the case of the SMCM, the source response checks serve as a measure of the condition of the detector, preamps, and MCAs. Quality control charts for the source response checks will be maintained for each detector.

A density gauge will be used, and source response checks will be performed by the SMCM software whenever the belt is free of material.

4.7 Data Analysis

Implementation of a laboratory radiation detector in the field requires that added quality control / quality assurance measures be taken. Some of these added measures, as the standard measures described above in section 4.6, can be taken and evaluated before processing. However, the source of information for the majority of these measures comes from the data itself. The measures can only be evaluated after processing. The post analysis and data processing are described below; collectively, the two are commonly referred to as post processing.

4.7.1 Recorded Data

In order to achieve the needed detection limit and throughput, a large number of parameters will be recorded and analyzed by the SMCM system. For each acquisition, the live time and raw spectra is recorded for the detector. During operation, a summary file is also generated which records virtually every parameter that was collected or calculated for each acquisition.

The NASVD algorithms will be performed during the post processing. NASVD is a spectral component analysis procedure for the removal of noise from gamma-ray spectra. The procedure transforms observed spectra into orthogonal spectral components. The lower-order components represent the signal in the original observed spectra, and the higher-order components represent uncorrelated noise. Noise is removed from the observed spectra by rejecting noise components and reconstructing the spectra from lower-order components. The raw spectra files will be loaded for a particular data set and the NASVD software determines the principal components. Identification of point sources is one of the tasks for which NASVD is very efficient.

5. SORTING RESULTS

Summary reports for each L-Pile and O-Pile will be documented on the form "Sorting Release Record" as shown in Attachment #1.

Table 5-1 presents the proposed summary of the laboratory radiological information collected for random verification.

Table 5-1. Typical summary of laboratory radiological information collected.

	Lab [pCi/g]			
Pile Name	Value	2 Sigma	Detect	Sample Log Number
O-1-B	2.0	0.0	No	123456
L-41-A	55.0	1.0	Yes	513274
O-12-A	30.0	1.0	Yes	113280

5.1 SMCM vs. Lab

The sorting data will be analyzed for any indication of bias between the SMCM and lab reported Tl-208. Sources of bias may be attributed to several sources: additional background counts come from the lower energy and add counts to the Tl-208 window from the material underneath and around the conveyor. Another contributing factor may be the use of a window that includes some Compton scattered photons as well as the primary photons assumed in the calibration model.

6. MARK III CONTAMINATION MONITORS

The characterization toolset is comprised of two tools: walk over activity monitor and an *in situ* contamination bucket monitor. The Mark III Contamination Monitor consist of a 3x3 NaI detector with a single channel analyzer. These tools have associated check-out and usage procedures, record the data for later analysis on a computer and have automated tools to gather and report the data.

6.1 Activity Monitor

This tool will be used in two modes: for walk over measurements and for static *in situ* measurements.

Walk-Over Mode: This tool utilizes the SRA model Mark III Contamination Monitor. This tool performs surface scans using an unshielded (or minimally shielded) detector. In this configuration the detector mounts to a hand-operated distance measuring device and is carried by the technician. This unit allows for quick monitoring where shine from nearby radiation sources is not of concern and where surface conditions are safe for workers to enter. This tool can also be used to screen the 2-foot lifts during backfill operations.

Static or Direct Push Mode: This tool utilizes the SRA model Mark III Contamination Monitor. This tool performs a spot check of the raw material "drying pile" or other areas in the raw material pond. In this configuration the detector is pushed into the raw material with raw material backfilled over the entire detector. This tool will be used in conjunction with the Walk-Over mode to subtract shine.

6.2 *In Situ* Bucket Monitor

This tool utilizes the SRA model Mark III Contamination Monitor. This tool provides 3 types of information: optimizes where to stop digging, allows the operator to identify levels of Th-232 in the material being excavated, and gives a rough analysis of the material being placed into a dump truck. A totalizer on the excavator will count each bucket going into a dump truck. The total will be manually reset with the information transferred by voice radio to the dump truck driver to indicate where the load should be dumped. This tool also reduces the volume of material that needs to be shipped off-site by pre-sorting into 2 piles: either < 31.1 pCi/g of Th-232 net or ≥ 31.1 pCi/g of Th-232 net.

7. RESPONSIBILITIES

SRA will be responsible for data collection and analysis from the SMCM and operated by a single Radiological Engineer or technician.

Quality control checks and data review will be done by an SRA engineer located in Marietta, GA.

Maintenance and repair of SRA equipment will be handled by an SRA mechanical engineer.

RECON's health physics technician(s) (HPT), equipment operators and/or appropriate designee will be trained to use the Mark III Contamination Monitors.

8. MOBILIZATION

Currently, mobilization by SRA to the Tulsa job site is planned for April 26th, 2004. The conveyor system will be installed and commissioned before SRA's arrival. The SRA system should take one week to install, calibrate and run a performance test on the SMCM system.

9. PROCEDURES

SRA will use the following SRA procedures:

Subsurface Multi-spectral Contamination Monitor (SMCM)

- SMCM Procedure 004
  - Source Response Checks and Performance Based Checks of any NaI Detector Configuration Installed on the SMCM
- SMCM Procedure 005
  - Calibration and Confirmation of a SMCM Incremental Encoder
- SMCM Procedure 006
  - Requirements for Completion of a Survey Using the SMCM
- SMCM Procedure 007
  - Calibration of NaI Detector

Mark III Contamination Monitor

- Mark III Contamination Monitor Procedure 001
  - Calibration of Mark III Contamination Monitor NaI Detector
- Mark III Contamination Monitor Procedure 002
  - Requirements for Completion of a Survey Using the *In Situ* Bucket Monitor
- Mark III Contamination Monitor Procedure 003
  - Requirements for Completion of a Survey Using the Walk/Roll Over Activity Monitor (ROAM)
- Mark III Contamination Monitor Procedure 004
  - Requirements for Completion of a Survey Using the Subsurface Contamination Radiation Activity Monitor (SCRAM)
- Mark III Contamination Monitor Procedure 005
  - Source Response Checks and Performance Based Checks of any Mark III Contamination Monitor NaI Detector

SRA will adhere to the following RECON plans:

RECON Radiation Health and Safety Plan (RHASP), Current Version

RECON Environmental Health and Safety Plan (EHASP), Current Version

All applicable RECON procedures

Shonka Procedure: SMCM 004

Source Response Checks and Performance Based Checks of any NaI Detector Configuration Installed on the SMCM

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **04**

EFFECTIVE DATE: **MAY 2004**

Approved Bill Vinzant

J. W. (Bill) Vinzant – Project Manager

5-10-04

Date

Kaiser Aluminum & Chemical Corporation

Shonka Procedure: SMCM 004

Source Response Checks and Performance Based Checks of any NaI Detector Configuration Installed on the SMCM

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **04**

EFFECTIVE DATE: **MAY 2004**

5/7/04
Danny P. Brown – Project Manager / Date

5/7/04
Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

Control Copy #______

Shonka Research Associates, Inc.
4939 Lower Roswell Road, Suite 106
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770-509-7606

Subsurface Multi-spectral Contamination Monitor

SMCM Procedure 004, Rev4

Source Response Checks and Performance Based Checks of any NaI Detector Configuration Installed on the SMCM

Table A 1. Revision Table

REVISION	AUTHOR(S)	DATE	BRIEF SUMMARY OF CHANGES
001	M. Marcial	11/5/01	Style
002	D. Debord	11/25/01	Equation 1 and Grammatical
003	M. Marcial	2/14/03	Added to Project Manager responsibilities. Added conditions to be followed when the SMCM Process Software is configured to report net values. Added the option to use the SMCM Process Software PBC feature for SRCs and PBCs.
004	K. Murray	4/1/04	Added exemption for PBCs when conditions warrant.

REVIEWED BY: Michael Marcial		**DATE:**
QA REVIEW BY: Deborah Shonka	Deborah B. Shonka	**DATE:**

EFFECTIVE DATE: 4/1/04

1. Purpose

This procedure details the requirements for baseline Source Response Checks (SRC), daily SRCs, and Performance Based Checks (PBC) of any NaI detector configuration installed on the SMCM.

2. Scope and Limitations

This procedure applies to version 1.0 or later of the SMCM process software.

3. Definitions and Acronyms

Table 1. Definitions and Acronyms.

ITEM	DESCRIPTION
SMCM	The Subsurface Multispectral Contamination Monitor is a mobile platform containing detectors, support electronics, and data logger used for conducting radiological surveys.
SIMS	Survey Information Management System – SIMS is flexible and comprehensive interfacing software for the SRA SMCM. SIMS processes the SMCM instrument data with a sophisticated data parser, integrated spreadsheet, and powerful special functions such as spatial data filters. SIMS provides the most flexible reporting system available for printing survey records or complete stand-alone survey reports. SIMS contains all the tools needed to meaningfully communicate between the SMCM and the data analysis team.
NaI	M-Style detector with the photo multiplier tube optically coupled to a NaI crystal. A mu-metal magnetic/light shield over the PMT completes the detector. A low energy X-ray lead umbrella shield covers the detector and PMT. The detector is attached to a preamplifier and encased in a thermally insulated electrically shielded container.
SRC	Source Response Check – Determines if the detector is operating the same from day-to-day.
PBC	Performance Based Check – Provides measurement of the system's performance in field conditions.
ROI	Region of Interest – Channels assigned to a particular isotope.

4. General Information

Normal operation of the SMCM with a NaI requires daily SRCs to assure that the NaI is performing within acceptable limits. Perform this procedure at the beginning and end of each shift for each detector in use. Compare the results of the daily SRC to the baseline SRC for this project. Use the initial daily SRC for a project as the baseline SRC.

Any time a system component or operating parameter changes, take a new baseline SRC for comparison with proceeding days. Examples of altered parameters would be:

1. Calibration source changed.
2. Detector replaced.

Perform Performance Based Checks (PBC) at a minimum of approximately every 5 hours during performance of the survey. The PBCs confirm constant system performance. The measurements are used to bound surveys. Failure of a PBC constitutes rejection of the surveys it bounds.

5. Materials, Equipment, and Supplies.

Table 2. Materials, Equipment, and Supplies.

ITEM	SPECIFICATION
SMCM	Platform and with detector height and width specifications as determined by Project Manager.
SMCM Process Software	Version 1.0 or later.
MCA Process Software	Maestro, ScintiVision, or equivalent.
SIMS	Current approved version.
NaI	Insulated Sodium Iodide detectors with mu and low energy gamma ray shields.
Check Source	As determined by Project Manager.

6. Responsibilities

6.1. Project Manager

6.1.1. Determines the check source type and activity to use

6.1.2. Determines the ROIs to be used for the SRCs.

6.1.3. Evaluates SRCs that fail the acceptance criteria

6.1.4. Determines if the SMCM Process Software will be configured to report net values using active background subtraction.

6.1.5. Has successfully completed SMCM Level II Training.

6.2. Operator

6.2.1. Reads and becomes familiar with this procedure before performing calibration.

6.2.2. Performs all measurements in accordance with this procedure.

6.2.3. Has successfully completed SMCM Level I training.

7. Procedure

7.1. Background Spectra Check Measurement

7.1.1. If the SMCM Process Software is configured to report net values, then take a 10-minute background spectra using ScintiVision. Compare the shape of the whole spectra to previously stored spectra. Perform this measurement before the SRC and PBC measurements.

7.2. Source Response Check Measurement using MCA Software

7.2.1. If this is a baseline SRC, use the form in Appendix A, "Baseline Source Response Check Form"; otherwise, use the form in Appendix B, "Daily Source Response Check Form." Use this procedure for all detectors regardless of configuration. Perform all Source Response Checks with the detector and source stationary. Use the source placement jig on the detector.

Note: Check sources are matched to each detector at the beginning of the survey. For each detector use only check sources that have been specifically assigned to that detector.

7.2.2. The Project Manager will provide a list of Isotopes and corresponding ROIs as well as count times for the sources. Generally, count times are 1 to 5 minutes yielding 10,000 to 100,000 net cpm.

7.2.3. Launch MCA software and select detector of interest.

7.2.4. Make sure that there are no unshielded sources near the detector.

7.2.5. Clear the display and initiate a count.

7.2.6. When the count is complete, integrate each ROI and record the number of background counts for each isotope.

7.2.7. Record the measured background on the appropriate form in the column labeled "ROI Background Counts" and the corresponding isotope row.

7.2.8. Place the appropriate check source in the source jig on the detector.

7.2.9. Clear the display and initiate a count.

7.2.10. When the count is complete, integrate each ROI and record the number of source counts for each isotope.

7.2.11. Record the measured source counts on the appropriate form in the column labeled "ROI Source Counts" and the corresponding isotope row.

7.2.12. Repeat Steps 7.2.8-7.2.11 for each isotope of interest.

7.2.13. Repeat Steps7.2.3-7.2.12 for each detector in the NaI array. If more than one detector is used and more than one check source is available, then multiple detectors may be counted in step 7.2.12 by placing a source on each detector.

7.3. Source Response Check Measurement using SMCM Process Software

7.3.1. If the SMCM Process Software is configured to report net values and the only isotope of concern is Cs-137, then this section may be used to measure and track the SRCs. There must be as many check sources available as detectors in the SMCM detector array.

7.3.2. The Project Manager will provide a list of Isotopes and corresponding ROIs as well as count times for the sources. Generally, count times are 1 to 5 minutes yielding 10,000 to 100,000 net cpm.

7.3.3. Perform all Source Response Checks with the detector and source stationary. Use the source placement jig on the detector.

Note: Check sources are matched to each detector at the beginning of the survey. For each detector use only check sources that have been specifically assigned to that detector.

7.3.4. Place the appropriate check sources in the source jig on each detector.

7.3.5. Launch SMCM Process software and execute the PBC feature and follow the on screen prompts.

7.4. Source Response Check Evaluation

7.4.1. If section 7.3 was used to take the SRCs, then follow this step and skip the rest of this section. Otherwise, skip this step. The SMCM Process software uses a stored spreadsheet that updates with the new count values and displays a graph. Compare the graph values with the acceptance criteria contained in Step 8.1.2. If the value is greater than the acceptance criteria, notify the Project Manager.

7.4.2. For each ROI, subtract the recorded background entered in the data table in the column labeled "ROI Background Counts" from the recorded "ROI Source Counts" for each detector, and enter the result in the "ROI Net Counts" column.

Note: If this procedure is being done to establish a baseline, it is now complete.
If this is a comparison to baseline, proceed to step 7.4.3

7.4.3. Copy values in the column labeled "ROI Net Counts" from the baseline form for each detector onto the form "Daily Source Response Check Form" in the column labeled "Baseline Net Counts" provided in Appendix B.

7.4.4. For each detector perform the calculation shown in Equation 1 and record the value in block "Percent Difference from Baseline Measurement" on the form in Appendix B.

$$100 \times \left| \frac{Daily\ NetCounts - Baseline\ NetCounts}{Baseline\ NetCounts} \right|$$

Equation 1

7.4.5. Compare these values with the acceptance criteria contained in Step 8.1.2. If the value is greater than the acceptance criteria, notify the Project Manager.

7.5. Survey Performance Based Checks

Note: Perform Performance Based Checks (PBCs) with the detectors operating in the mode in which the surveys bounded by the Performance Based Checks will be performed.

7.5.1. Perform periodic PBCs during the performance of the survey, unless conditions prevent the PBC from being implemented. Perform PBCs at the beginning of the shift, approximately every 5 hours of surveying, and at the completion of each shift.

7.5.2. Document if conditions prevent PBCs from being performed.

Note: Check sources are matched to each detector at the beginning of the survey. For each detector use only check sources that have been specifically assigned to that detector. The source used for efficiency determination is acceptable but not required to be used.

7.5.3. Obtain PBCs in the same performance manner as normal surveys, i.e. detector height, heating, amplifier gain.

7.5.4. If the SMCM Process Software is configured to report net values, you may skip steps 7.5.5 through 7.5.8 and use the SMCM Process software PBC feature by following all steps in section 7.3. This technique will graph the initial daily SRC and all subsequent daily PBCs on the same chart.

7.5.5. Place each source onto its corresponding detector.

7.5.6. Press the <Record> button. Continue the strip until at least 20 acquisitions have been logged.

7.5.7. Record the time, filename, strip numbers, and the source used in the logbook or survey form.

7.5.8. Repeat 7.5.6 through 7.5.7 without the sources present to establish a background for the PBC.

7.5.9. Evaluation of the PBCs for the duration of the survey occurs in the survey report issued upon completion of the survey.

8. Acceptance Criteria

8.1. SRC

8.1.1. For baseline SRCs, there is no acceptance criterion.

8.1.2. Daily SRCs are acceptable if all "Percent Difference from Baseline Measurement" values are less than 20%

8.2. PBC

8.2.1. Use SIMS to process the PBC data files. Optionally, if the PBC option within the SMCM Process software was used to collect and generate the control charts, the data has already been processed into a control chart. Establish a control chart indicating the mean and "2-sigma" and "3-sigma" values. Evaluate subsequent PBCs against the "2-sigma" and "3-sigma" criteria and for indications of adverse trends. If two consecutive measurements obtained during a PBC are greater than the "2-sigma" or if any measurement is greater than "3-sigma", the PBC fails.

8.2.2. Surveys bounded by a failed PBC are considered suspect. The nature of the failure must be determined. The Project Manager has the option to invalidate surveys bounded by a failed SRC.

9. References

N/A

10. Required Records

The forms in Appendix A and B shall be kept with the survey documentation.

If the SMCM Process software was used to generate spreadsheets and graphs, the Excel files are required to be kept with the survey documentation.

11. Appendices

11.1. Appendix A: Baseline Source Response Check Form

11.2. Appendix B: Daily Source Response Check Form

Appendix A

Baseline Source Response Check Form

Baseline Source Response Check Form

SMCM CONFIGURATION: ____________________ SMCM SERIAL NUMBER: ____________________

DETECTOR SERIAL NUMBER OR ID: ________

ISOTOPE / SERIAL NUMBER	ROI CHANNELS	ROI BACKGROUND COUNTS	ROI SOURCE COUNTS	ROI NET COUNTS

NOTE: ENTER N/A FOR ALL NON-EXISTING ISOTOPES

PERFORMED BY: ________________________________ DATE: ____________________

REVIEWED BY: ________________________________ DATE: ____________________

Appendix B

Daily Source Response Check Form

Daily Source Response Check Form

BASELINE SOURCE RESPONSE CHECK CONFIGURATION DATE: ____________________

SMCM CONFIGURATION: ____________________ SMCM SERIALNUMBER: ____________________

DETECTOR SERIAL NUMBER OR ID: __________

ISOTOPE / SERIAL NUMBER	ROI CHANNELS	ROI BACKGROUND COUNTS	ROI SOURCE COUNTS	ROI NET COUNTS	BASELINE NET COUNTS	PERCENT DIFFERENCE FROM BASELINE MEASUREMENT

ENTER N/A FOR ALL NON-EXISTING ISOTOPES

INITIALS ___ NO MEASUREMENT VARIES MORE THAN 20% FROM BASELINE

INITIALS ___ PASSED

PERFORMED BY: ______________________________ DATE: ____________________

REVIEWED BY: ______________________________ DATE: ____________________

Shonka Procedure: SMCM 005

Calibration and Confirmation of a SMCM Incremental Encoder

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **03**

EFFECTIVE DATE: **MAY 2004**

Approved, Bill Vinzant
J. W. (Bill) Vinzant – Project Manager

5-10-04
Date

Kaiser Aluminum & Chemical Corporation

Shonka Procedure: SMCM 005

Calibration and Confirmation of a SMCM Incremental Encoder

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **03**

EFFECTIVE DATE: **MAY 2004**

5/7/04
Danny P. Brown – Project Manager / Date

5/7/04
Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

Control Copy #______

Shonka Research Associates, Inc.
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Subsurface Multi-spectral Contamination Monitor

SMCM Procedure 005, Rev3

Calibration and Confirmation of a SMCM Incremental Encoder

Table A 1. Revision Table

REVISION	AUTHOR(S)	DATE	BRIEF SUMMARY OF CHANGES
001	M. Marcial	11/5/01	Style
002	D. Debord	11/25/01	Added Definition
003	M. Marcial	2/14/03	Added encoder confirmation when the platform is stationary and the material to be surveyed is moving. Unified names and Appendix A, Appendix B and the procedure text.

REVIEWED BY: Javid Kelley		**DATE:**
QA REVIEW BY: Deborah Shonka	Deborah B. Shonka	**DATE:**

EFFECTIVE DATE: 3/6/03

1. Purpose

The purpose of this procedure is to establish the methods for calibration and verification of the incremental encoder included on the SMCM.

2. Scope and Limitations

Any SMCM used to conduct a rolling survey must have completed a valid encoder confirmation. A new encoder confirmation must be performed IF any of the following occur.

1. Maintenance on the encoder.
2. Disassembly/re-assembly of the system or platform.
3. A new computer, software, or encoder is added to the cart.
4. 24 months since last confirmation.
5. Anomalies in the reported strip distance are noticed by the operator.

Calibration should be performed whenever the mean of an encoder confirmation exceeds 1% error.

3. Definitions and Acronyms

Table 1. Definitions and Acronyms.

ITEM	DESCRIPTION
SMCM	The Subsurface Multispectral Contamination Monitor is a mobile platform containing detectors, support electronics, and data logger used for conducting radiological land surveys.
Incremental Encoder	Electronic device used to measure distance via rotation.
Target Survey Speed	Maximum survey speed determined to support required MDA.
MDA	Minimum Detectable Activity.
TTL	Transistor Transistor Logic

4. General Information

The incremental encoder provides a method of determining the distance traveled by the SMCM. As the encoder turns, TTL level pulses are generated at regular intervals. A calibration factor in pulses per inch allows the SMCM to determine distance by number of pulses. This calibration factor could be determined by dividing the pulses per rotation by the circumference of the wheel. To reduce the impact of measurement error this procedure determines the calibration factor by rolling the cart a known distance and dividing by the pulses received by the counter card in the SMCM to get a pulse/in factor. The user must be cautious to operate the SMCM in straight lines. Failure to do so can result in distance errors of more than 1%.

5. Materials, Equipment, and Supplies

Table 2. Materials, Equipment, and Supplies.

ITEM	SPECIFICATION
SMCM Platform with installed incremental encoder	Any Model
SMCM Software	Version 2.0 or later
Tape Measure or Laser Range Finder	100 m or Suitable Equivalent
Location marking	Flags or Poles
Survey Documentation	Survey Logbook

6. Responsibilities

6.1. Operator

6.1.1. Reads and becomes familiar with this procedure before performing calibration.

6.1.2. Has successfully completed SMCM I training.

6.1.3. Ensures the measurements are performed according to this procedure.

7. Procedure

7.1. Encoder Confirmation for Moving Platforms

7.1.1. Mark a beginning position by placing a marker directly beneath the centerline of the detector array.

7.1.2. Place a second marker at a distance of 30m for user-propelled systems or 100m for vehicular-propelled systems.

7.1.3. Initiate the measurement by pressing the "Record" button.

7.1.4. Begin moving the SMCM platform toward the second flag.

Note: The platform must be kept traveling in a straight line or the reported distance may be misreported in relation to the actual distance.

7.1.5. Stop the platform when the centerline of the detector array lines up with the second flag.

7.1.6. Complete the measurement by pressing the "Stop" key.

7.2. Encoder Confirmation for Stationary Platforms

7.2.1. If a conveyor is used to transport material by the stationary SMCM then follow this section.

7.2.2. Measure the distance of the conveyor belt that the wheel encoder will ride on.

7.2.3. Mark the belt. This mark will be used to start and end the recording of a strip.

7.2.4. Initiate the measurement by pressing the "Record" button when the mark passes by a reference point.

7.2.5. Record a strip that is at least 75 meters. The belt may need to make more than 1 revolution.

7.2.6. Stop the measurement by pressing the "Stop" button when the mark passes by the starting reference point.

7.2.7. Calculate the actual distance the mark traveled.

7.3. Encoder Confirmation Evaluation

7.3.1. Record the reported and actual distances (in meters) in Appendix A "Incremental Encoder Calibration Verification Data Sheet."

7.3.2. Repeat steps 7.1 or 7.2 two additional times for a total of three measurements.

7.3.3. Calculate the mean and the percent deviation from the mean for each of the three measurements using Equation 1. Record the mean and percent deviation from the mean for each measurement in Appendix A "Incremental Encoder Calibration Verification Data Sheet."

Equation 1

$$Deviation\% = \left|\frac{Mean - Measurement}{Mean}\right| * 100$$

7.3.4. If the mean of the three measurements differs from the actual distance by more than 1%, proceed to 7.4 and perform an encoder calibration.

7.3.5. Calculate the percent deviation of the mean from the actual distance using Equation 2. Record the value in Appendix A "Incremental Encoder Calibration Verification Data Sheet."

Equation 2

$$Deviation\% = \left|\frac{Mean - ActualLength}{Mean}\right| * 100$$

7.3.6. If the deviation from the mean is larger than 3% for any measurement, repeat the confirmation test or troubleshoot encoder.

7.4. Encoder Calibration

7.4.1. Perform confirmation measurements outlined in 7.1 or 7.2.

7.4.2. Record the mean of the three confirmation measurements in the logbook.

7.4.3. Calculate a new encoder calibration constant based on the confirmation measurements average. Record the following on the Appendix B "Encoder Calibration Data Sheet":

- Enter the old encoder calibration constant in $Constant_{old}$
- For conveyor systems, enter the actual distance the mark traveled in *ActualDistance.*
- For user-propelled systems, enter the 30 in *ActualDistance.*
- For vehicular-propelled systems, enter 100 in *ActualDistance.*
- Enter the value shown on the SMCM Process software screen labeled "Distance Traveled [m]" in *REportedDistance.*

7.4.4. Set software to new encoder calibration constant.

7.4.5. Perform encoder confirmation in Section 7.1 to verify new encoder calibration constant.

8. Acceptance Criteria

Completion of a successful encoder confirmation routine.

All encoder confirmation and/or calibration information has been recorded in the survey logbook.

9. References

9.1. SMCM Procedure 006, "Requirements for Completion of a Survey Using the SMCM."

10. Required Records

10.1. Survey Logbook

11. Appendices

11.1. Appendix A: Incremental Encoder Calibration Verification Data Sheet

11.2. Appendix B: Encoder Calibration Data Sheet

Appendix A

Incremental Encoder Calibration Verification Data Sheet

Appendix A

Incremental Encoder Calibration Verification Data Sheet

Date: ____________ SMCM S/N: ______________

SMCM Speed: ____________

Note: The test should be performed at the intended survey speed.

Table 1: Strip Distances

Measurement	Distance (Meters)	Dev. From Mean (%)	Dev. From Mean Limit (%)
1			3
2			3
3			3
Mean		N/A	N/A
Actual Distance*		N/A	N/a

*Distance between flags for moving platforms or marks on a conveyor for stationary platforms.

Mean deviation from actual distance: ________ %

Init ____ **Mean Deviation from Actual Distance less than 1%**

Init ____ **Deviation from Mean for each Measurement within 3% of the Actual Distance**

Performed By: ________________________ Date: ____________ Time:__________

Reviewed By: ________________________ Date: ____________ Time:__________

Appendix B

Encoder Calibration Data Sheet

Appendix B

Encoder Calibration Data Sheet

Date: ___________ SMCM S/N: ____________

SMCM Speed: ___________

Note: The test should be performed at the intended survey speed.

ReportedDistance (this is the value shown on the SMCM Process software screen labeled "Distance Traveled [m]") Enter the mean of 3 distance measurements.	_________	m
$Constant_{Old}$	_________	pulse/m
ActualDISTANCE (Distance between flags for moving platforms or marks on a conveyor for stationary platforms.)	_________	m

$$Constant_{New} = \frac{Constant_{Old} * ActualDISTANCE}{REportedDistance}$$

$Constant_{New}$: ____________ pulse/m

Init ____ **SMCM Process software updated with *$Constant_{New}$***

Init ____ **Perform encoder confirmation.**

Performed By: ______________________ Date: ___________ Time:__________

Reviewed By: ______________________ Date: ___________ Time:__________

Shonka Procedure: SMCM 006

Requirements for Completion of a Survey Using the SCMC

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **03**

EFFECTIVE DATE: **MAY 2004**

Approved, Bill Vinzant

J. W. (Bill) Vinzant – Project Manager

5-10-04

Date

Kaiser Aluminum & Chemical Corporation

Shonka Procedure: SMCM 006

Requirements for Completion of a Survey Using the SCMC

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **03**

EFFECTIVE DATE: **MAY 2004**

5/7/04 | 5/7/04

Danny P. Brown – Project Manager / Date | Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

Control Copy #______

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Subsurface Multi-spectral Contamination Monitor

SMCM Procedure 006, Rev 3

Requirements for Completion of a Survey Using the SMCM

Table A 1. Revision Table

REVISION	AUTHOR(S)	DATE	BRIEF SUMMARY OF CHANGES
000	M. Marcial	11/12/01	Major Revision to 001
001	D. Debord	11/25/01	Stop Work Conditions
002	M. Marcial	2/14/03	Added section when SMCM platform is used in stationary mode and a conveyor transports material by the system.
003	K. Murray	4/1/04	Added assessment of Stop Work Conditions.

REVIEWED BY: Michael Marcial		**DATE:**
QA REVIEW BY: Deborah Shonka	Deborah B. Shonka	**DATE:**

EFFECTIVE DATE: 4/1/04

1. Purpose

The purpose of this procedure is to detail the requirements for completion of a survey using the SMCM.

2. Scope and Limitations

This procedure applies to version 1.0 or later of the process software.

3. Definitions and Acronyms

Table 1. Definitions and Acronyms.

ITEM	DESCRIPTION
SMCM	The Subsurface Multispectral Contamination Monitor is a mobile platform containing detectors, support electronics, and data logger used for conducting radiological surveys.
SIMS	Survey Information Management System – SIMS is flexible and comprehensive interfacing software for the SRA SMCM. SIMS processes the SMCM instrument data with a sophisticated data parser, integrated spreadsheet, and powerful special functions such as spatial data filters. SIMS provides the most flexible reporting system available for printing survey records or complete stand-alone survey reports. SIMS contains all the tools needed to meaningfully communicate between the SMCM and the data analysis team.
NaI	M-Style detector with the photo multiplier tube optically coupled to a NaI crystal. A mu-metal magnetic/light shield over the PMT completes the detector. A low energy X-ray lead umbrella shield covers the detector and PMT. The detector is attached to a preamplifier and encased in a thermally insulated electrically shielded container.
SRC	Source Response Check – Determines if the detector is operating the same from day-to-day.
PBC	Performance Based Check – Provides measurement of the system's performance in field conditions.
ROI	Region of Interest – Channels assigned to a particular isotope.
MCA	Multi-Channel Analyzer-Equipment used to view spectral data.

4. General Information

4.1. Scanning Mode

Upon arrival on site, the encoder will be checked per SMCM Procedure 005 and the NaIs will be source checked per SMCM Procedure 004 and calibrated per SMCM Procedure 007.

The array mounted NaI detectors can be used for both scanning and *in situ*. Survey speed will be established by the Project Manager based on the isotopes of concern and sensitivity to be attained.

For Moving Platforms: A survey is conducted in a series of strips, which can be reassembled in SIMS to provide complete documentation of a survey without requiring any manual transfer of data. To accomplish a survey an operator first makes a crude sketch of the area and indicates the direction and start point of each strip. The file name of the survey should be recorded on the sketch and a reference coordinate for the South West corner of the survey area should be noted. The survey is divided into strips by placing large markers and flags on opposing edges of the survey area. The operator starts the SMCM software if it is not already active and enters the survey parameters: Survey Name (File Name), and Operator ID. The SMCM platform scans strait strips of the survey area. Once the entire accessible survey area has been covered by the SMCM, the survey is complete. *In situ* measurements may be incorporated into the survey in areas that are not accessible to the SMCM.

For Stationary Platforms: A survey is conducted in a series of strips, which can be reassembled in SIMS to provide complete documentation of a survey without requiring any manual transfer of data. To accomplish a survey an operator decides what a collection of strips will represent, i.e., a 250-ton pile of material, a B-25 container, etc. The filename of the survey should be recorded in the logbook. The operator starts the SMCM software if it is not already active and enters the survey parameters: Survey Name (File Name), and Operator ID. The SMCM platform scans strips of the survey material. This procedure will reference the movement of the material past the SMCM platform as a conveyor. Other conveying mechanisms may be used besides a typical conveyor with belt. Once the entire collection of strips area has been covered by the SMCM, the survey is complete.

4.2. *In situ* mode

In situ surveys using the SMCM platform should be performed per SMCM Procedure 002.

5. Materials, Equipment, and Supplies

Table 2. Materials, Equipment, and Supplies.

ITEM	SPECIFICATION
SMCM platform	Any platform with detector heights and spacing as determined by survey team leader.
Software	SMCM Process
Field Notes	Logbook
Reference markers	Existing landmarks or identified known GPS locations
Strip markers	Flags or Equivalent
Differential GPS (if available)	Any device capable of outputting NEMA strings that the SMCM Process software can interpret

6. Responsibilities

6.1. Operator

6.1.1. Reads and becomes familiar with this procedure before performing calibration.

6.1.2. Ensures all surveys are performed according to this procedure.

6.1.3. Operates the SMCM during the survey.

6.1.4. Guides and Monitors the SMCM's speed throughout the surveys.

6.1.5. Has successfully completed SMCM I training.

6.2. Project Manager

6.2.1. Reads and becomes familiar with this procedure.

6.2.2. Confirms the quality of SMCM operations.

6.2.3. Periodically confirms quality of collected SMCM data.

6.2.4. Has successfully completed SMCM II Training.

6.2.5. Establish SMCM survey speed and NaI temperatures.

7. Procedure

7.1. Initial SMCM Preparation

7.1.1. Confirm the survey platform is in good working condition and is setup appropriately for the survey area environment.

7.1.2. *For Moving Platforms:* Establish a reference heading e.g. Magnetic, True, or Map North, or a direction based on permanent site landmarks. All data strips will be taken parallel or perpendicular to the reference heading.

7.1.3. Turn detector heaters on and set thermostat to temperature determined by Project Manager.

WARNING
The temperature of the NaI detectors should not exceed 100° F.

7.1.4. *For Moving Platforms:* When available, turn differential GPS on.

7.1.5. Calibrate SMCM encoder per SMCM Procedure 005.

7.1.6. If not already done, calibrate NaI detectors per SMCM Procedure 007.

7.2. Survey Setup

7.2.1. If using a gas generator, ensure there is enough gas in the generator to complete the survey area.

7.2.2. If using the radon detector, start the pump 20 minutes before data collection.

7.2.3. If using the detector thermal stabilizers, start the electronics 20 minutes before data collection.

7.2.4. Start the SMCM software if it was not already running.

7.2.5. Align detectors using the SMCM Process software alignment feature.

7.2.6. If this is the beginning of a shift, perform daily Source Response Check and Performance Based Check per SMCM Procedure 004.

7.2.7. *For Moving Platforms:* Establish a survey grid. The edges of the survey grid must be parallel or perpendicular to the established reference heading. Square or rectangular (with the longer edge being the primary direction of travel) survey grids are generally more efficient. The time of the survey generally increases with the number of strips required to cover the grid.

7.2.8. *For Moving Platforms:* Make a crude sketch of the survey area including distances.

7.2.9. *For Moving Platforms:* Identify SW corner on drawing and provide a reference coordinate, if available.

7.2.10. *For Moving Platforms:* When available, take a differential GPS reading in the South West corner of the survey grid.

7.2.11. Record the date, time, location, and detector temperatures in the logbook.

7.2.12. *For Moving Platforms:* Indicate strip locations and directions on sketch with arrows.

7.2.13. *For Moving Platforms:* Identify and mark the first survey lane using a tape measure and stake or other markings. Center a stake at the end of the first strip.

7.3. Scanning Survey Operations

7.3.1. When prompted by the SMCM software, enter a survey name and record the name on the sketch of the survey. For stationary platforms, there is no sketch of the area.

7.3.2. *For Moving Platforms:* When possible, move the SMCM platform to the South West corner of the survey grid. Else, move to the most easily accessible corner, and align the detector array even with the edge of the survey grid, pointed in the direction of travel.

7.3.3. Start recording the strip by hitting the <Start> button in the SMCM software. For Stationary Platforms, assure the conveyor is clear of material. After pressing the start button, the SMCM process software will indicate it is ready for material after its internal filters are conditioned. The initial conditioning of the filters happens only when the software is first started or the operator performs a filter reset.

7.3.4. *For Moving Platforms:* Using a marker at the other side of the survey grid as a target, drive the array across the survey area at the speed determined by the Project Manager.

7.3.5. *For Moving Platforms:* If obstacles prevent completing the strip, stop the strip by hitting the <Stop> button in the SMCM software, note on survey sketch, start a second strip on the other side of the obstacle, or turn the platform around and repeat steps 7.3.3 through 7.3.5.

7.3.6. *For Stationary Platforms:* After a pre-determined time or if the conveyor is out of material, stop the strip by pressing the <Stop> button. The Project Manager determines the pre-determined time of a typical strip. The SMCM software may stay in record mode when no material is present. However, it is not recommended to un-necessarily record background data.

7.3.7. *For Stationary Platforms:* If the SMCM Process software indicates an alarm, then wait for the conveyor to stop, and then stop the strip by pressing the <Stop> button. Use the SMCM Process software post-visualization feature to identify the type of alarm and its location along the conveyor.

7.3.8. *For Moving Platforms:* Once the array is over the marker at the opposite edge of the survey grid, hit the <Stop> button to complete the survey strip.

7.3.9. *For Moving Platforms:* Turn the array around and align it next to the previous one.

7.3.10. Monitor the SMCM Process software alignment peak window after every strip, every 30-minutes or whenever it is suspected that the system is becoming misaligned. Mis-alignment is typically seen when the ambient temperature is changing.

7.3.11. Repeat 7.3.3 through 7.3.7 until all accessible areas of the survey grid have been surveyed.

7.3.12. Record the stop time in the logbook.

7.3.13. Perform Performance Based Checks in accordance with SMCM Procedure 004

7.4. Stop work conditions

Note: Under the following conditions, an assessment shall be made that evaluates if these conditions impact survey data.

7.4.1. Onset of moderate rain or snowfall that removes radon daughters from air and their impact on product measurement.

7.4.2. Standing water in excess of .5 inches deep or snow in excess of 6 inches deep over areas larger than 10 m^2, unless specifically approved by the Project Manager.

7.4.3. Movement of sources greater than 50 nCi at a distance of 1 meter from a detector. The activity shall be adjusted for inverse square relation.

7.4.4. Rapid change in ground level radon daughter product concentration due to inversion.

7.4.5. Large temperature changes.

8. Acceptance Criteria

None, outside of the reference procedures.

9. References

9.1. SMCM Procedure 005 "Calibration and Confirmation of Incremental Encoder"

9.2. SMCM Procedure 004 "Source Response Checks and Performance Based Checks of any NaI Detector Configuration Installed on the SMCM"

9.3. SMCM Procedure 007 "Calibration of NaI detector"

10. Required Records

N/A

11. Appendices

N/A

Shonka Procedure: SMCM 007

Calibration of NaI Detector

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **02**

EFFECTIVE DATE: **MAY 2004**

Approved Bill Vinzant

J. W. (Bill) Vinzant – Project Manager

5-10-04

Date

Kaiser Aluminum & Chemical Corporation

Shonka Procedure: SMCM 007

Calibration of NaI Detector

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **02**

EFFECTIVE DATE: **MAY 2004**

5/7/04
Danny P. Brown – Project Manager / Date

5/7/04
Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

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Subsurface Multi-spectral Contamination Monitor

SMCM Procedure 007, Rev2

Calibration of NaI Detector

Table A 1. Revision Table

REVISION	AUTHOR(S)	DATE	BRIEF SUMMARY OF CHANGES
000	M. Marcial	11/5/01	Major Revision to 003
001	D. Debord	11/25/01	Added Calibration Stickers
002	M. Marcial	2/14/03	Added Project Manager responsibilities. Added required records.

REVIEWED BY: Javid Kelley		**DATE:**
QA REVIEW BY: Deborah Shonka	Deborah B. Shonka	**DATE:**

EFFECTIVE DATE: 3/6/03

1. Purpose

The purpose of this procedure is to define the operational methods and requirements for performing a detector/source calibration with any MkIII.

2. Scope and Limitations

N/A

3. Definitions and Acronyms

Table 1. Definitions and Acronyms.

ITEM	DESCRIPTION
SMCM	The Subsurface Multispectral Contamination Monitor is a mobile platform containing detectors, support electronics, and data logger used for conducting radiological surveys.
SIMS	Survey Information Management System – SIMS is flexible and comprehensive interfacing software for the SRA SMCM. SIMS processes the SMCM instrument data with a sophisticated data parser, integrated spreadsheet, and powerful special functions such as spatial data filters. SIMS provides the most flexible reporting system available for printing survey records or complete stand-alone survey reports. SIMS contains all the tools needed to meaningfully communicate between the SMCM and the data analysis team.
NaI	M-Style detector with the photo multiplier tube optically coupled to a NaI crystal. A mu-metal magnetic/light shield over the PMT completes the detector. A low energy X-ray lead umbrella shield covers the detector and PMT. The detector is attached to a preamplifier and encased in a thermally insulated electrically shielded container.
SRC	Source Response Check – Determines if the detector is operating the same from day-to-day.
PBC	Performance Based Check – Provides measurement of the system's performance in field conditions.
ROI	Region of Interest – Channels assigned to a particular isotope.

4. General Information

Before any gamma spectroscopy in support of land surveys are performed with NaI detectors, all detectors must be calibrated. The data collected from the calibration will be used to calculate calibration factors for the duration of the survey. The calibration factor will convert count rate into planar or deposited concentrations.

5. Material Equipment and Supplies

Table 2 . Materials, Equipment, and Supplies.

ITEM	SPECIFICATION
Detector	Any size NaI or equivalent gamma detector.
Software	MCB software
NIST traceable Check Sources	^{60}Co, ^{137}Cs & other if Scope requires.
Hardware	µAce or µNomad MCA
Computer	Desktop PC or PocketPC
Field Notes	Log Book

6. Responsibilities

6.1. Technician

6.1.1. Reads and becomes familiar with this procedure.

6.1.2. Ensures that all measurements are made in accordance with this procedure.

6.2. Project Manager

6.2.1. Determines the calibration source and count times to use.

6.2.2. Ensures that all measurements are made in accordance with this procedure.

7. Procedure

7.1. Alignment of NaI Spectrum

7.1.1. Prior to performing the calibration, alignment of the spectrum channels shall be performed.

7.1.2. Alignment shall occur for each detector in use.

7.1.3. The alignment is typically performed using the ^{40}K background peak.

7.1.4. The alignment is performed by adjusting the gain in the SMCM or MCA software to shift the ^{40}K peak until the center of the 1461 keV peak is centered in channel 250, when the multi-channel analyzer is set to a conversion gain of 512 channels.

7.2. Calibration of NaI Detectors

7.2.1. Prior to field use, each NaI detector will be calibrated to NIST traceable sources. Calibrations will include ^{60}Co and ^{137}Cs sealed sources, or other isotopes approved by the Project Manager based on the specific survey requirements.

7.2.2. Calibration of the NaI detector will be performed by taking a 10-minute background using the NaI detector/MCA system.

7.2.3. Then take a 10-minute count with the source exactly 1 meter below the bottom face of the crystal. The count time may be varied based upon the source strength. (determined by the Project Manager).

7.2.4. Visually inspect the recorded peak and record the net counts, center channel and FWHM in the logbook.

7.2.5. Record the background and source spectra in the computer as a *.CHN file.

7.2.6. Perform Source Response Check and Performance Based Check in accordance with SMCM Procedure 004 to establish traceability to the calibration measurement.

7.2.7. Affix a calibration sticker to the detector. The due date shall not exceed 6 months from the current date.

7.2.8. Repeat steps 7.2.2 to 7.2.7 for each detector to be used.

8. Acceptance criteria

8.1. Reported source to NaI crystal distance is within ±5mm.

9. References

N/A

10. Required Records

10.1. Background and Source *.CHN files.

11. Appendices

N/A

Shonka Procedure: Mark III Contamination Monitor 001

Calibration of Mark III Contamination Monitor NaI Detector

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **00**

EFFECTIVE DATE: **MAY 2004**

Approved, Bill Vinzant — 5-10-04

J. W. (Bill) Vinzant – Project Manager — Date

Kaiser Aluminum & Chemical Corporation

Shonka Procedure: Mark III Contamination Monitor 001

Calibration of Mark III Contamination Monitor NaI Detector

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **00**

EFFECTIVE DATE: **MAY 2004**

5/7/04 5/7/04

Danny P. Brown – Project Manager / Date   Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

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MkIII Contamination Monitor

MkIIICM Procedure 001, Rev0

Calibration of MkIIICM NaI Detector

Table A 1. Revision Table

REVISION	AUTHOR(S)	DATE	BRIEF SUMMARY OF CHANGES

REVIEWED BY:		DATE:
QA REVIEW BY:		DATE:

EFFECTIVE DATE: 4/1/04

1. Purpose

The purpose of this procedure is to define the operational methods and requirements for performing a detector/source calibration with any MkIII. The MkIII is a Sodium Iodide (NaI) detector and electronics encased in a protective housing.

2. Scope and Limitations

N/A

3. Definitions and Acronyms

Table 1. Definitions and Acronyms.

ITEM	DESCRIPTION
NaI	M-Style detector with the photo multiplier tube optically coupled to a NaI crystal. A mu-metal magnetic/light shield over the PMT completes the detector. A low energy X-ray lead umbrella shield covers the detector and PMT. The detector is attached to a preamplifier and encased in a thermally insulated electrically shielded container.
SRC	Source Response Check – Determines if the detector is operating the same from day-to-day.
PBC	Performance Based Check – Provides measurement of the system's performance in field conditions.

4. General Information

Before any gamma spectroscopy in support of land surveys are performed with NaI detectors, all detectors must be calibrated. The data collected from the calibration will be used to calculate calibration factors for the duration of the survey. The calibration factor will convert count rate into planar or deposited concentrations.

5. Material Equipment and Supplies

Table 2. Materials, Equipment, and Supplies.

ITEM	SPECIFICATION
Detector	Any size NaI or equivalent gamma detector.
NIST traceable Check Sources	^{60}Co, ^{137}Cs & other if Scope requires.
Computer	PocketPC
Field Notes	Log Book

6. Responsibilities

6.1. Technician

6.1.1. Reads and becomes familiar with this procedure.

6.1.2. Ensures that all measurements are made in accordance with this procedure.

6.2. Project Manager

6.2.1. Determines the calibration source and count times to use.

6.2.2. Ensures that all measurements are made in accordance with this procedure.

7. Procedure

7.1. Calibration of MkIIICM NaI Detectors

7.1.1. Prior to field use, each NaI detector will be calibrated to NIST traceable sources. Calibrations may include ^{60}Co and ^{137}Cs sealed sources, or other isotopes approved by the Project Manager based on the specific survey requirements.

7.1.2. Perform a 10-minute background of the NaI detector.

7.1.3. Perform a 10-minute count with the source placed one meter from the center of the detector. The count time may be varied based upon the source strength. (Determined by the Project Manager).

7.1.4. Review the data collected.

7.1.5. Perform Source Response Check and Performance Based Check (if applicable) in accordance with MkIIICM Procedure 005 to establish traceability to the calibration measurement.

7.1.6. Affix a calibration sticker to the detector. The due date shall not exceed 6 months from the current date.

7.1.7. Repeat steps 7.1.2 to 7.1.6 for each detector to be used.

8. Acceptance criteria

8.1. Reported source to NaI crystal distance is within ±5mm.

9. References

N/A

10. Required Records

10.1. Calibration data sheets

11. Appendices

N/A

Shonka Procedure: Mark III Contamination Monitor 002

Requirements for Completion of a Survey Using the In Situ Contamination Bucket Monitor

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **00**

EFFECTIVE DATE: **MAY 2004**

Approved, Bill Vinzant
J. W. (Bill) Vinzant – Project Manager

5/10-04
Date

Kaiser Aluminum & Chemical Corporation

Shonka Procedure: Mark III Contamination Monitor 002

Requirements for Completion of a Survey Using the In Situ Contamination Bucket Monitor

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **00**

EFFECTIVE DATE: **MAY 2004**

5/7/04 5/7/04

Danny P. Brown – Project Manager / Date Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

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MkIII Contamination Monitor

MkIIICM Procedure 002, Rev0

Requirements for Completion of a Survey Using the ICBM

Table A 1. Revision Table

REVISION	AUTHOR(S)	DATE	BRIEF SUMMARY OF CHANGES

REVIEWED BY:		**DATE:**
QA REVIEW BY:		**DATE:**

EFFECTIVE DATE: 4/1/04

1. Purpose

The purpose of this procedure is to define the operational methods and requirements for using a MkIII as a sub-system in a *In Situ* Contamination Bucket Monitor (ICMB). The MkIII is a Sodium Iodide (NaI) detector and electronics encased in a protective housing.

2. Scope and Limitations

N/A

3. Definitions and Acronyms

Table 1. Definitions and Acronyms.

ITEM	DESCRIPTION
ICBM	The *In Situ* Contamination Bucket Monitor containing a NaI detector encased in a protective housing used for estimating activity of the soil excavated or loaded.
NaI	M-Style detector with the photo multiplier tube optically coupled to a NaI crystal. A mu-metal magnetic/light shield over the PMT completes the detector. A low energy X-ray lead umbrella shield covers the detector and PMT. The detector is attached to a preamplifier and encased in a thermally insulated electrically shielded container.
SRC	Source Response Check – Determines if the detector is operating the same from day-to-day.

4. General Information

The *In Situ* Contamination Bucket Monitor optimizes where to stop digging, identification of unknown material, and estimating activity of raw material placed into a dump truck.

5. Material Equipment and Supplies

Table 2 . Materials, Equipment, and Supplies.

ITEM	SPECIFICATION
NaI detector	Model 3
QC Check Source	Typically a Cs-137 source
Field Records	Log book

6. Responsibilities

6.1. Technician

6.1.1. Reads and becomes familiar with this procedure.

6.1.2. Ensures that all measurements are made in accordance with this procedure.

6.2. Project Manager

6.2.1. Ensures proper placement of ICBM on excavator or equivalent.

6.2.2. Reviews the survey information.

7. Procedure

7.1. Calibration of MkIIICM NaI Detectors

7.1.1. Calibration shall be performed per MkIIICM Procedure 001.

7.2. Source Response and Performance Based Check of NaI detectors

7.2.1. The Source Response and Performance Based Checks for the NaI are described in MkIIICM Procedure 005.

7.3. Operation of the ICBM

7.3.1. Turn on Pocket PC to activate the ICBM. This can be done either from the cab of the equipment or from the ground.

7.3.2. Ensure the total is reset for counting bucket loads, for each truck that is.

7.3.3. Start logging data from the ICBM prior to excavating or loading.

7.3.4. Upon completion of excavating or loading stop data logging on the Pocket PC.

7.3.5. Return the Pocket PC to technician if applicable for review of data collected.

8. Acceptance criteria

Surveys performed in accordance with this procedure are designed to identify different levels of radioactivity for possible segregation of soil.

Response check data shall be evaluated for the survey. Control chart data should indicate specific acceptance criteria for the survey being performed. Response check values outside the prescribed acceptance band shall be evaluated for their impact on the survey and dispositioned or those areas impacted re-surveyed.

9. References

9.1. MkIIICM Procedure 001, "Calibration of MkIIICM NaI Detector"

9.2. MkIIICM Procedure 005, "Source Response Checks and Performance Based Checks of any MkIIICM NaI Detector"

10. Required Records

N/A

11. Appendices

N/A

Shonka Procedure: Mark III Contamination Monitor 003

Requirement for Completion of a Survey Using the Walk over Activity Monitor

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **00**

EFFECTIVE DATE: **MAY 2004**

Approved Bill Vinzant

J. W. (Bill) Vinzant – Project Manager

5-10-04

Date

Kaiser Aluminum & Chemical Corporation

Shonka Procedure: Mark III Contamination Monitor 003

Requirement for Completion of a Survey Using the Walk over Activity Monitor

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **00**

EFFECTIVE DATE: **MAY 2004**

5/7/04
Danny P. Brown – Project Manager / Date

5/7/04
Richard Lewis – Quality Control Supervisor / Date

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MkIII Contamination Monitor

MkIIICM Procedure 003, Rev0

Requirements for Completion of a Survey Using the Walk/Roll Over Activity Monitor (ROAM)

Table A 1. Revision Table

REVISION	AUTHOR(S)	DATE	BRIEF SUMMARY OF CHANGES

REVIEWED BY:		DATE:
QA REVIEW BY:		DATE:

EFFECTIVE DATE: 4/1/04

1. Purpose

The purpose of this procedure is to define the operational methods and requirements for using a MkIII as a sub-system in a Walk/Roll Over Activity Monitor (ROAM). The MkIII is a Sodium Iodide (NaI) detector and electronics encased in a protective housing.

2. Scope and Limitations

N/A

3. Definitions and Acronyms

Table 1. Definitions and Acronyms.

ITEM	DESCRIPTION
ROAM	The Walk/Roll Over Activity Monitor is a mobile platform containing NaI detectors and data logger used for conducting radiological surveys.
NaI	M-Style detector with the photo multiplier tube optically coupled to a NaI crystal. A mu-metal magnetic/light shield over the PMT completes the detector. A low energy X-ray lead umbrella shield covers the detector and PMT. The detector is attached to a preamplifier and encased in a thermally insulated electrically shielded container.
SRC	Source Response Check – Determines if the detector is operating the same from day-to-day.

4. General Information

ROAM gamma surveys are performed with NaI detectors set at a constant height above the ground surface. The objective of the survey is to verify when an area is below set site-specific limits.

5. Material Equipment and Supplies

Table 2. Materials, Equipment, and Supplies.

ITEM	SPECIFICATION
NaI detector	Model 3
QC Check Source	Typically a Th-232 source
Field Records	Log book

6. Responsibilities

6.1. Technician

6.1.1. Reads and becomes familiar with this procedure.

6.1.2. Ensures that all measurements are made in accordance with this procedure.

6.2. Project Manager

6.2.1. Defines locations, count time and detector height for all measurements.

6.2.2. Reviews the net count rates.

7. Procedure

7.1. Calibration of MkIIICM NaI Detectors

7.1.1. Calibration shall be performed per MkIIICM Procedure 001.

7.2. Source Response and Performance Based Check of MkIIICM NaI detectors

7.2.1. The Source Response and Performance Based Checks for the NaI are described in MkIIICM Procedure 005.

7.3. Walkover Mode Surveys

7.3.1. Walkover surveys are performed using a NaI detector mounted to a location-based sensor or distance encoder when applicable.

7.3.2. Perform surveys by walking over designated survey lanes with the detector held at a constant level (typically about 1 meter). Survey lanes are separated by twice the height of the detector above the ground (e.g. if the detector is one meter above ground, survey lanes are 2 meters apart).

7.3.3. Start logging survey information on Pocket PC.

7.3.4. Upon completion of survey stop logging data on Pocket PC.

7.3.5. Review data collected upon completion of survey.

Note: This type of setup allows for quick surveys where backgrounds tend to be low and not influenced by nearby radiation sources. If backgrounds are influenced by nearby radiation sources, use of shielded detectors mounted on a platform used in Drive Over Mode shall be performed.

7.4. Drive Over Mode Surveys

7.4.1. Drive Over surveys are performed using a heavily shielded NaI detectors mounted on a platform that can be carried by a Bobcat or equivalent equipment.

7.4.2. Perform surveys by driving over designated survey lanes with the detector held at a constant level (typically about 1 meter).

7.4.3. Start logging survey information on Pocket PC.

7.4.4. Upon completion of survey stop logging data on Pocket PC.

7.4.5. Review data collected upon completion of survey.

8. Acceptance criteria

Surveys performed in accordance with this procedure are designed to identify areas that are above site-specific limits and not to quantify levels of radioactivity.

Response check data shall be evaluated for the survey. Control chart data should indicate specific acceptance criteria for the survey being performed. Response check values outside the prescribed acceptance band shall be evaluated for their impact on the survey and dispositioned or those areas impacted re-surveyed.

9. References

9.1. MkIIICM Procedure 001, "Calibration of MkIIICM NaI Detector"

9.2. MkIIICM Procedure 005, "Source Response Checks and Performance Based Checks of any MkIIICM NaI Detector"

10. Required Records

N/A

11. Appendices

N/A

Shonka Procedure: Mark III Contamination Monitor 004

Requirements for Completion of a Survey Using the Static Contamination Radiation Activity Monitor

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **00**

EFFECTIVE DATE: **MAY 2004**

Approved Bill Vinzant
J. W. (Bill) Vinzant – Project Manager

5-10-04
Date

Kaiser Aluminum & Chemical Corporation

Shonka Procedure: Mark III Contamination Monitor 004

Requirements for Completion of a Survey Using the Static Contamination Radiation Activity Monitor

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **00**

EFFECTIVE DATE: **MAY 2004**

5/7/04 5/7/04

Danny P. Brown – Project Manager / Date

Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

Control Copy #______

Shonka Research Associates, Inc.
4939 Lower Roswell Road, Suite 106
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MkIII Contamination Monitor

MkIIICM Procedure 004, Rev0

Requirements for Completion of a Survey Using the Subsurface Contamination Radiation Activity Monitor (SCRAM)

Table A 1. Revision Table

REVISION	AUTHOR(S)	DATE	BRIEF SUMMARY OF CHANGES

REVIEWED BY:		**DATE:**
QA REVIEW BY:		**DATE:**

EFFECTIVE DATE: 4/1/04

1. Purpose

The purpose of this procedure is to define the operational methods and requirements for using a MkIII as a sub-system in a Subsurface Contamination Radiation Activity Monitoring (SCRAM). The MkIII is a Sodium Iodide (NaI) detector and electronics encased in a protective housing.

2. Scope and Limitations

N/A

3. Definitions and Acronyms

Table 1. Definitions and Acronyms.

ITEM	DESCRIPTION
SCRAM	The Subsurface Contamination Radiation Activity Monitor containing a NaI detector used for conducting radiological surveys.
NaI	M-Style detector with the photo multiplier tube optically coupled to a NaI crystal. A mu-metal magnetic/light shield over the PMT completes the detector. A low energy X-ray lead umbrella shield covers the detector and PMT. The detector is attached to a preamplifier and encased in a thermally insulated electrically shielded container.
SRC	Source Response Check – Determines if the detector is operating the same from day-to-day.

4. General Information

SCRAM surveys are performed with NaI detectors for use in the ground or a sample container. The objective of the survey is to verify activity in the soil for areas that may have influence from radioactive sources.

5. Material Equipment and Supplies

Table 2. Materials, Equipment, and Supplies.

ITEM	SPECIFICATION
NaI detector	Model 3
QC Check Source	Typically a Cs-137 source
Field Records	Log book

6. Responsibilities

6.1. Technician

6.1.1. Reads and becomes familiar with this procedure.

6.1.2. Ensures that all measurements are made in accordance with this procedure.

6.2. Project Manager

6.2.1. Defines locations and count times for all measurements.

6.2.2. Reviews the net count rates.

7. Procedure

7.1. Calibration of MkIIICM NaI Detectors

7.1.1. Calibration shall be performed per MkIIICM Procedure 001.

7.2. Source Response and Performance Based Check of NaI detectors

7.2.1. The Source Response and Performance Based Checks for the NaI are described in MkIIICM Procedure 005.

7.3. Subsurface mode Surveys

7.3.1. Subsurface surveys are performed using a NaI detector encased in a plastic tube.

7.3.2. Perform surveys by inserting the detector into borehole or sample location and start logging information on Pocket PC.

7.3.3. Upon completion of survey count stop logging data on Pocket PC.

7.3.4. Review data collected upon completion of survey.

7.4. Sample mode Surveys

7.4.1. Sample mode surveys are performed using a NaI detector encased in a plastic tube.

7.4.2. Perform surveys by inserting detector into holding fixture and place sample container (large volume Marinelli or equivalent geometry) on detector for counting.

7.4.3. Start logging survey information on Pocket PC.

7.4.4. Upon completion of survey stop logging data on Pocket PC.

7.4.5. Review data collected upon completion of survey.

8. Acceptance criteria

Surveys performed in accordance with this procedure are designed to identify areas that are above site-specific limits and not to quantify levels of radioactivity.

Response check data shall be evaluated for the survey. Control chart data should indicate specific acceptance criteria for the survey being performed. Response check values outside the prescribed acceptance band shall be evaluated for their impact on the survey and dispositioned or those areas impacted re-surveyed.

9. References

9.1. MkIIICM Procedure 001, "Calibration of MkIIICM NaI Detector"

9.2. MkIIICM Procedure 005, "Source Response Checks and Performance Based Checks of any MkIIICM NaI Detector "

10. Required Records

N/A

11. Appendices

N/A

Shonka Procedure: Mark III Contamination Monitor 005

Source Response Checks and Performance Based Checks of any Mark III Contamination Monitor NaI Detector

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **00**

EFFECTIVE DATE: **MAY 2004**

Approved Bill Vinzant
J. W. (Bill) Vinzant – Project Manager

5-10-04
Date

Kaiser Aluminum & Chemical Corporation

Shonka Procedure: Mark III Contamination Monitor 005

Source Response Checks and Performance Based Checks of any Mark III Contamination Monitor NaI Detector

Thorium Remediation Project
Tulsa, Oklahoma

REVISION: **00**

EFFECTIVE DATE: **MAY 2004**

5/7/04
Danny P. Brown – Project Manager / Date

5/7/04
Richard Lewis – Quality Control Supervisor / Date

Remedial Construction Services, L.P.

Control Copy #______

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MkIII Contamination Monitor

MkIIICM Procedure 005, Rev00

Source Response Checks and Performance Based Checks of any MkIII Detector

Table A 1. Revision Table

REVISION	AUTHOR(S)	DATE	BRIEF SUMMARY OF CHANGES

REVIEWED BY:		DATE:
QA REVIEW BY:		DATE:

EFFECTIVE DATE: 4/1/04

1. Purpose

This procedure details the requirements for baseline Source Response Checks (SRC), daily SRCs, and Performance Based Checks (PBC) of any MkIIICM NaI detector.

2. Scope and Limitations

N/A

3. Definitions and Acronyms

Table 1. Definitions and Acronyms.

ITEM	DESCRIPTION
NaI	M-Style detector with the photo multiplier tube optically coupled to a NaI crystal. A mu-metal magnetic/light shield over the PMT completes the detector. A low energy X-ray lead umbrella shield covers the detector and PMT. The detector is attached to a preamplifier and encased in a thermally insulated electrically shielded container.
SRC	Source Response Check – Determines if the detector is operating the same from day-to-day.
PBC	Performance Based Check – Provides measurement of the system's performance in field conditions.

4. General Information

Normal operation of the MkIIICM NaI requires daily SRCs to assure that the NaI is performing within acceptable limits. Perform this procedure at the beginning and end of each shift for each detector in use. Compare the results of the daily SRC to the baseline SRC for this project. Use the initial daily SRC for a project as the baseline SRC.

Any time a system component or operating parameter changes, take a new baseline SRC for comparison with proceeding days. Examples of altered parameters would be:

1. Calibration source changed.
2. Detector replaced.

Perform Performance Based Checks (PBC) at a minimum of approximately every 5 hours during performance of the survey. The PBCs confirm constant system performance. The measurements are used to bound surveys. Failure of a PBC constitutes investigations of the surveys it bounds.

5. Materials, Equipment, and Supplies.

Table 2. Materials, Equipment, and Supplies.

ITEM	SPECIFICATION
NaI	Insulated Sodium Iodide detectors with mu and low energy gamma ray shields.
Check Source	Th-232 or as determined by Project Manager.

6. Responsibilities

6.1. Project Manager

6.1.1. Determines the check source type and activity to use

6.1.2. Evaluates SRCs that fail the acceptance criteria

6.2. Operator

6.2.1. Reads and becomes familiar with this procedure before performing calibration.

6.2.2. Performs all measurements in accordance with this procedure.

7. Procedure

7.1. Background Check Measurement

7.1.1. Make sure that there are no unshielded sources near the detector.

7.1.2. Perform a 10-minute background check

7.1.3. Retrieve data from Pocket PC.

7.1.4. Record the measured background on the appropriate form in the column labeled "Background Counts".

7.2. Source Response Check Measurement

7.2.1. If this is a baseline SRC, use the form in Appendix A, "Baseline Source Response Check Form"; otherwise, use the form in Appendix B, "Daily Source Response Check Form." Perform all Source Response Checks with the detector and source stationary. Use the source placement tube on the detector.

Note: Check sources are matched to each detector at the beginning of the survey. For each detector use only check sources that have been specifically assigned to that detector.

7.2.2. Make sure that there are no unshielded sources near the detector.

7.2.3. Place the appropriate check source in the source tube on the detector.

7.2.4. Perform 10-minute source check.

7.2.5. Retrieve data from Pocket PC.

7.2.6. Record the measured source counts on the appropriate form in the column labeled "Source Counts".

7.3. Source Response Check Evaluation

7.3.1. For each detector perform the calculation shown in Equation 1 and record the value in block "Percent Difference from Baseline Measurement" on the form in Appendix B.

$$100 \times \left| \frac{\text{Daily NetCounts} - \text{Baseline NetCounts}}{\text{Baseline NetCounts}} \right|$$

Equation 1

7.3.2. Compare these values with the acceptance criteria contained in Step 8.1.2. If the value is greater than the acceptance criteria, notify the Project Manager.

7.4. Survey Performance Based Checks

Note: Perform Performance Based Checks (PBCs) with the detectors operating in the mode in which the surveys bounded by the Performance Based Checks will be performed.

7.4.1. Perform periodic PBCs during the performance of the survey, unless conditions prevent the PBC from being implemented. Perform PBCs at the beginning of the shift, approximately every 5 hours of surveying, and at the completion of each shift.

7.4.2. Document if conditions prevent PBCs from being performed.

Note: Check sources are matched to each detector at the beginning of the survey. For each detector use only check sources that have been specifically assigned to that detector. The source used for efficiency determination is acceptable but not required to be used.

7.4.3. Obtain PBCs in the same performance manner as normal surveys, i.e. detector height, heating, amplifier gain.

7.4.4. Place each source in a position corresponding to actual survey conditions.

7.4.5. Survey the source as dictated by the actual survey platform and survey instructions.

7.4.6. Evaluation of the PBCs for the duration of the survey occurs in the survey report issued upon completion of the survey.

8. Acceptance Criteria

8.1. SRC

8.1.1. For baseline SRCs, there is no acceptance criterion.

8.1.2. Daily SRCs are acceptable if all "Percent Difference from Baseline Measurement" values are less than 20%

8.2. PBC

8.2.1. Use the post-processing software to track the PBC data files. Establish a control chart indicating the mean and "2-sigma" and "3-sigma" values. Evaluate subsequent PBCs against the "2-sigma" and "3-sigma" criteria and for indications of adverse trends. If two consecutive measurements obtained during a PBC are greater than the "2-sigma" or if any measurement is greater than "3-sigma", the PBC indicates change in survey performance. The reason for the change must be evaluated before accepting the survey data. The Project Manager has the option to invalidate surveys bounded by a failed SRC.

9. References

N/A

10. Required Records

The forms in Appendix A and B shall be kept with the survey documentation.

Excel files are required to be kept with the survey documentation.

11. Appendices

11.1. Appendix A: Baseline Source Response Check Form

11.2. Appendix B: Daily Source Response Check Form

Appendix A

Baseline Source Response Check Form

Baseline Source Response Check Form

DETECTOR SERIAL NUMBER OR ID: ______

DATE/ TIME	ISOTOPE / SERIAL NUMBER	BACKGROUND COUNTS	SOURCE COUNTS	NET COUNTS

NOTE: ENTER N/A FOR ALL NON-EXISTING ISOTOPES

PERFORMED BY: ______________________ DATE: ____________

REVIEWED BY: ______________________ DATE: ____________

Appendix B

Daily Source Response Check Form

Daily Source Response Check Form

BASELINE SOURCE RESPONSE CHECK CONFIGURATION DATE: ____________________

DETECTOR SERIAL NUMBER OR ID: ________

DATE/TIME	ISOTOPE / SERIAL NUMBER	BACKGROUND COUNTS	SOURCE COUNTS	NET COUNTS	BASELINE NET COUNTS	PERCENT DIFFERENCE FROM BASELINE MEASUREMENT

ENTER N/A FOR ALL NON-EXISTING ISOTOPES

INITIALS ___ NO MEASUREMENT VARIES MORE THAN 20% FROM BASELINE

INITIALS ___ PASSED

PERFORMED BY: ______________________________ DATE: ________________

REVIEWED BY: ______________________________ DATE: ________________

Attachment 1

Sorting Release Record

Pile Name	L-0001-A
Sorting Equipment	Sub-Surface Multi-Spectral Contamination Monitor
Sorting Date	12-May-2004 15:29:52, 12-May-2004 14:41:48
Sorter Operator	K. Murray
Sorted Material	Soil and Dross
Criteria	55.0 pCi/g
Number of Measurements	921
Tons Sorted	100.0

Table 1. SMCM Concentrations reported in pCi/g.

Isotope	Mean	Median	Maximum	Minimum	2-Sigma
Th-232	45.9	43.0	79.2	25.5	0.13