

**ATAL-BELGOPROCESS JOINT VENTURE**


**Contract No. EP/SP/40/02**

**Low Level Radioactive Waste Storage  
Facility at Siu A Chau**

**Eleventh Environmental Monitoring and Audit Report  
(Operation Phase)**

**Version 1.0**

September 2007

Certified By 
(Environmental Team Leader)

**REMARKS:**

The information supplied and contained within this report is, to the best of our knowledge, correct at the time of printing.

The Environmental Team Leader accepts no responsibility for changes made to this report by third parties.

Dr. John K.C. Leung  
Department of Physics, The University of Hong Kong  
Pokfulam Road, Hong Kong.  
Tel: +852 2859 2858 Fax: +852 2471 8888  
E-mail: [jkleung@hku.hk](mailto:jkleung@hku.hk)

## TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>1</b>
BACKGROUND .....	2
PURPOSE OF THE REPORT .....	2
<b>2. MONITORING RESULTS.....</b>	<b>3</b>
AMBIENT $\gamma$ DOSE RATES .....	5
SAND .....	8
GRASS .....	9
SEA WATER.....	10
MARINE ORGANISMS.....	11
AIRBORNE PARTICULATES .....	13
<b>3. REPORT ON ELEVATED ENVIRONMENTAL RADIATION BACKGROUND</b>	<b>14</b>
<b>4. REPORT ON NON-COMPLIANCE .....</b>	<b>15</b>
DOSE FOR RADIATION WORKERS .....	15
DOSE RATES AT UN-CONTROLLED AREAS.....	15
LIQUID EFFLUENT DISCHARGE .....	15
AIRBORNE EFFLUENT DISCHARGE .....	15
<b>5. RESULT OF ENVIRONMENTAL COMPLIANCE AUDITS .....</b>	<b>16</b>
<b>APPENDIX 1 .....</b>	<b>17</b>
LIMIT LEVEL AND ACTION LEVEL .....	17
INVESTIGATION LEVEL .....	17

## **LIST OF TABLES**

- Table 2.1(a) Ambient  $\gamma$  Dose Rates at 1 m above Ground  
Table 2.1(b) Comparison of Ambient  $\gamma$  Dose Rates with Previous Results  
Table 2.2(a) Activity Concentration of Some Major Radionuclides in Soil Samples  
Table 2.2(b) Comparison of Activities in Soil with Previous Results  
Table 2.3(a) Activity Concentration of Some Major Radionuclides in Sand Samples  
Table 2.3(b) Comparison of Activities in Sand with Previous Results  
Table 2.4(a) Activity Concentration of Gross  $\alpha$  and  $\beta$  Emitters in Grass Samples  
Table 2.4(b) Comparison of  $\alpha/\beta$  Activities in Grass Samples with Previous Results  
Table 2.5(a) Activity Concentration of Gross  $\alpha/\beta$  Emitters in Sea Water Samples  
Table 2.5(b) Comparison of  $\alpha/\beta$  Activities in Sea Water Samples with Previous Results  
Table 2.6(a) Activity Concentration of Gross  $\alpha/\beta$  Emitters in Fish Samples  
Table 2.6(b) Comparison of  $\alpha/\beta$  Activities in Fish Samples with Previous Results  
Table 2.7(a) Activity Concentration of Gross  $\alpha/\beta$  Emitters in Sea Snail Samples  
Table 2.7(b) Comparison of  $\alpha/\beta$  Activities in Sea Snails with Previous Results  
Table 2.8(a) Net Gross  $\alpha/\beta$  Counts in Airborne Particulate Samples  
Table 2.8(b) Comparison of  $\alpha/\beta$  in Airborne Particulate Samples with Previous Samples  
Table A1.1 Limit Levels for Non-compliance and Action Levels  
Table A1.2 Investigation Levels for Environmental Samples

## **LIST OF FIGURES**

- Figure 2.1 Locations of the Sampling Sites

## **EXECUTIVE SUMMARY**

This is the first yearly report after the Facility has been operated for 2 years and it presents the results of the radiological monitoring work performed between September 11, 2006 and September 7, 2007. The sampling was done on September 7, 2007.

In the first year of operation, nine EM&As have been carried out with 6 monthly EM&As in the first 6 months and 3 bi-monthly EM&As in the remaining 6 months. Most of the environmental samples were found to have fluctuations within their respective Investigation Levels. One sand sample (Location C) showed a marked increase in radioactivities in the winter months and then returned back to the baseline level in the summer time. This is believed to be a seasonal variation due to the change in wind directions, but no firm conclusion can be made since the monitoring was not designed to cater for that.

Airborne particulates collected by the filter papers during the first year of operation also varied quite a bit as they were subjected to different environmental perturbations, such as wind, rain, etc during the collection period. But in general, it could be seen that the longer the sampling period, the higher the activities were.

Again and again, activities in fish samples collected in the first year of operation exceed the Investigation Level. This is expected as the fishes do not live in Siu A Chau and the source of their minute bodily activities were not traceable.

After 2 years of operation, there was only record of minute release of airborne radionuclides through the stack and the released radon gas was below the Action Limit. Also there was no record of radioactive liquid effluent. Given the well controlled release of the Facility, and the normal activities in environmental samples recorded in this EM&A, it can be concluded that the Facility was operating satisfactorily and there were no adverse effect to the environment.

## **INTRODUCTION**

### **Background**

- 1.1 Various industrial, educational and medical facilities in Hong Kong have, for a number of years, used radioactive materials and generated radioactive waste. Most of the existing waste arisings are stored in disused air raid tunnels close to Queen's Road East in Wan Chai. Other arisings are stored temporarily (although in some cases for several years) at the point of use in educational institutions or hospitals.
- 1.2 A consultancy study in 1995 concluded that Siu A Chau was a suitable location for a purpose-built storage facility to which all waste will be transported, placed in stainless steel drums and stored.
- 1.3 In July 2003 ATAL-Belgoprocess Joint Venture Limited (ABJV) was awarded a contract to design, construct, and operate the LRWF at Siu A Chau. Thereafter, the ABJV will transfer the waste management skills for this Facility to Hong Kong.
- 1.4 The LRWF was designed to have a storage vault that can initially store 260 drums of waste, each drum of 275 litres net capacity. The building will also contain facilities for waste reception and repackaging waste, and administering the process. A jetty will be built to provide marine access to the Facility.
- 1.5 The Facility is equipped with various radiation monitors inside the building specially installed for detecting all possible leakage of effluents from the building.
- 1.6 However, it is possible that minute activities may escape from detection and enter the biosphere, or an unexpected incidence would have resulted in a significant release of radionuclide from the Facility. It is one of the objectives of this environmental monitoring scheme to monitor whether in the long-term, the operation of the Facility will cause deterioration to the environment.

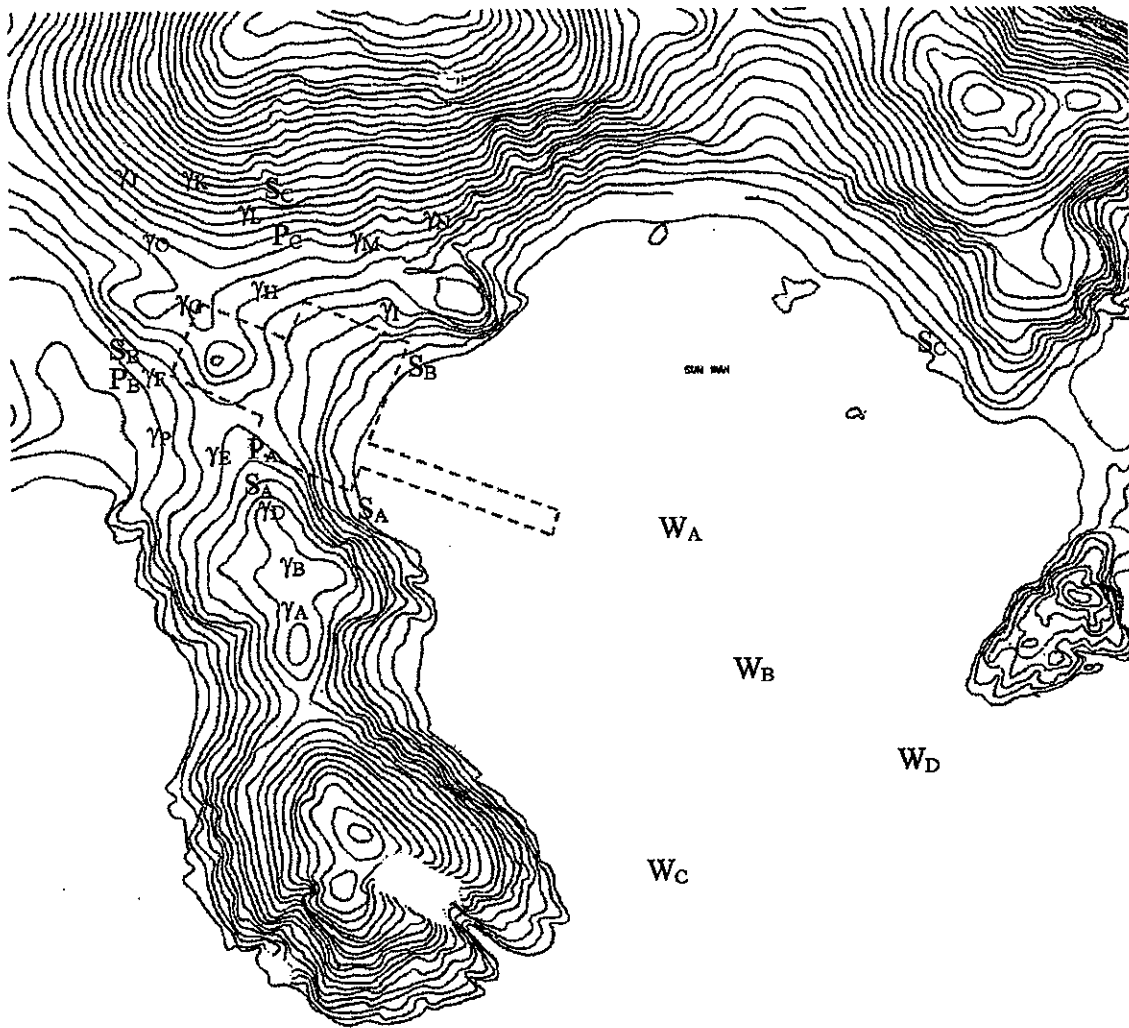
### **Purpose of the Report**

- 1.7 This is the eleventh EM&A (Operation Phase) report, which is also the first annual report on measurement results of environmental samples taken after the commencement of operation of the LRWF on July 28, 2005. This report covers the monitoring period from September 11, 2006 to September 7, 2007.
- 1.8 The requirements of the operation phase monitoring and audit; monitoring scheme and monitoring equipment and procedures have been fully described in the First EM&A (Operation Phase) Report. Please refer to that report for reference.
- 1.9 This report also covers the monitoring of personnel doses, the non-active areas of the Facility and the liquid and gaseous effluents.

---

## 2. MONITORING RESULTS

- 2.1 The sampling scheme remained unchanged. 15 in-situ ambient  $\gamma$  dose rates were measured. 3 soil samples; 3 sea sediment samples; 3 grass samples; 8 seawater samples from 4 locations at two depths; 1 kg of sea snails; a few fish and 3 airborne particulate samples were collected and analysed as in previous monitoring. **Figure 2.1** shows the locations for taking various samples.
- 2.2 Ambient  $\gamma$  dose rates were taken at exactly the same locations and would give a true picture of the variation of the radiation environment if there were any.
- 2.3 Soil and grass samples were collected at more or less the same place as for the baseline. Since we need fresh surface soils that would have stored information of fallout since the commencement of the operation, the sampling sites shifted a little bit every time.
- 2.4 The uncertainties of the measurement results are given as standard deviation (SD) or standard uncertainty (SU). SD is given for individual sample and is calculated according to the number of counts recorded and assuming a normal distribution for the counts. SU is reported for each group of samples and it takes into account of the variance between samples. Please refer to the First EM&A Report (Operation Phase) for details.



**Fig. 2.1 Locations of the Sampling Sites**

( $\gamma$ : Ambient gamma dose rate; S: Soil or Sand; W: Water; P: Air particulates)  
(Grass sampling sites are the same as soil sampling sites)

**Ambient  $\gamma$  Dose Rates**

2.5 The measurement results are given in the last column in Table 2.1(a). The 1<sup>st</sup> year results are average of all previous results measured within the 1<sup>st</sup> year. Table 2.1(b) also shows the results of the previous measurements for comparison. It is noted that the overall average value has not changed during the monitoring period.

**Table 2.1(a) Ambient  $\gamma$  Dose Rates at 1 m above Ground**

Location	$\gamma$ Dose Rate ( $\mu\text{Sv h}^{-1}$ )		
	Baseline	1 <sup>st</sup> Year ( $\pm 1$ SU)	2 <sup>nd</sup> Year ( $\pm 1$ SD)
Boat	0.07	0.06 $\pm$ 0.008	0.06 $\pm$ 0.005
A	0.21	0.22 $\pm$ 0.012	0.21 $\pm$ 0.012
B	0.22	0.24 $\pm$ 0.016	0.25 $\pm$ 0.013
D	0.23	0.26 $\pm$ 0.014	0.26 $\pm$ 0.013
E	0.25	0.23 $\pm$ 0.021	0.22 $\pm$ 0.012
F	0.24	0.27 $\pm$ 0.012	0.29 $\pm$ 0.014
G	0.23	0.26 $\pm$ 0.012	0.26 $\pm$ 0.013
H	0.27	0.29 $\pm$ 0.008	0.30 $\pm$ 0.014
I	--	0.29 $\pm$ 0.016	0.29 $\pm$ 0.014
J	0.21	0.23 $\pm$ 0.017	0.24 $\pm$ 0.012
K	0.28	0.27 $\pm$ 0.020	0.27 $\pm$ 0.013
L	0.22	0.26 $\pm$ 0.018	0.27 $\pm$ 0.013
M	0.27	0.28 $\pm$ 0.022	0.27 $\pm$ 0.013
N	0.25	0.25 $\pm$ 0.020	0.27 $\pm$ 0.013
O	--	0.22 $\pm$ 0.016	0.24 $\pm$ 0.012
P	--	0.25 $\pm$ 0.013	0.27 $\pm$ 0.013

-- Not measured

2.6 A slight exceedance of Investigation Level was observed in Location F.



**Table 2.1(b) Comparison of Ambient  $\gamma$  Dose Rates with Previous Results**

EM&A Report No.	Mean $\gamma$ Dose Rate ( $\mu\text{Sv h}^{-1}$ )	SU
1 (Baseline)	0.24	0.026
2	0.26	0.028
3	0.25	0.022
4	0.25	0.029
5	0.26	0.027
6	0.25	0.024
7	0.26	0.022
8	0.25	0.031
9	0.24	0.031
10	0.25	0.029
11 (2 <sup>nd</sup> Year)	0.26	0.025

2.7 The overall ambient  $\gamma$  dose-rate remained unchanged.

**Soil**

2.8 Soil samples were collected at 3 locations only, all from the undisturbed areas. These locations correspond to the passive air sampler locations which aim to detect dispersion of effluent leakages, if any, in the prevailing wind directions. The measurement results are given in Table 2.2(a) & (b).

**Table 2.2(a) Activity Concentration of Some Major Radionuclides in Soil Samples**

Location	Collection Date	Activity Concentration (Bq kg <sup>-1</sup> )							
		<sup>226</sup> Ra	SD	<sup>228</sup> Th	SD	<sup>40</sup> K	SD	<sup>137</sup> Cs	SD
A	7 Sept 07	69.9	0.5	91.6	0.8	704	5.0	0.28	0.16
B	7 Sept 07	49.5	0.5	125.1	0.9	538	4.5	*	*
C	7 Sept 07	39.0	0.4	103.7	0.8	207	3.1	0.27	0.15

\* Not detected

**Table 2.2(b) Comparison of Activities in Soil Samples with Previous Results**

EM&A Report No.	Mean Activity Concentration (Bq kg <sup>-1</sup> )							
	<sup>226</sup> Ra	SU	<sup>228</sup> Th	SU	<sup>40</sup> K	SU	<sup>137</sup> Cs	SU
1 (Baseline)	50.0	13.9	80.2	16.1	606	297	0.25	0.37
2	41.7	17.0	63.7	20.5	387	219	*	*
3	41.8	15.4	75.6	20.1	423	237	*	*
4	45.3	7.1	104.5	11.4	574	319	0.25	0.43
5	57.8	17.7	95.8	4.2	535	294	0.41	0.42
6	59.9	19.0	103.9	14.3	479	277	0.25	0.23
7	60.8	22.4	102.9	16.2	464	258	0.36	0.33
8	51.9	17.6	95.0	14.8	449	263	0.19	0.17
9	52.5	18.6	98.4	16.3	523	307	0.07	0.12
10	50.7	16.1	97.7	9.5	498	282	0.18	0.17
11 (2 <sup>nd</sup> Year)	52.8	15.7	106.8	17.5	483	253	0.27	0.01

\* Not detected

2.9 No exceedance of Investigation Level is observed.

**Sand**

2.10 The measurement results are shown in Table 2.3(a) & (b).

**Table 2.3(a) Activity Concentration of Some Major Radionuclides in Sand Samples**

Location	Collection Date	Activity Concentration (Bq kg <sup>-1</sup> )					
		<sup>226</sup> Ra	SD	<sup>228</sup> Th	SD	<sup>40</sup> K	SD
A	7 Sept 07	15.6	0.3	14.8	0.5	335	3.6
B	7 Sept 07	15.7	0.3	17.6	0.4	382	3.8
C	7 Sept 07	19.8	0.4	23.3	0.5	475	4.1

**Table 2.3(b) Comparison of Activities in Sand Samples with Previous Results**

EM&A Report No.	Mean Activity Concentration (Bq kg <sup>-1</sup> )					
	<sup>226</sup> Ra	SU	<sup>228</sup> Th	SU	<sup>40</sup> K	SU
1 (Baseline)	18.8	4.4	21.6	5.5	576	106
2	11.1	3.8	12.8	5.0	357	100
3	11.4	3.2	13.2	4.4	382	141
4	28.3	22.8	24.5	17.4	360	165
5	23.3	12.7	25.6	17.9	323	117
6	20.8	8.0	25.8	18.0	329	95.7
7	30.2	24.8	24.3	17.0	320	173
8	15.4	4.6	15.4	4.1	246	30.5
9	14.5	1.2	17.3	5.8	380	99.1
10	18.4	1.7	18.5	2.4	377	124
11 (2 <sup>nd</sup> Year)	17.0	2.4	18.6	4.4	397	71.3

2.11 No exceedance of Investigation Level is observed.

**Grass**

2.12 Grass samples were collected in locations near to the soil samples. The measurement results are given in Table 2.4(a) & (b). The  $\gamma$ -spectra are identical to the background of the  $\gamma$  spectrometer and do not reveal the presence of any significant  $\gamma$ -emitting radionuclides, hence they are not reported here.

**Table 2.4(a) Activity Concentration of Gross  $\alpha$  and  $\beta$  Emitters in Grass Samples**

Location	Collection Date	$\alpha$ Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )	$\beta$ Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )
A	7 Sept 07	0.038	0.000	0.311	0.002
B	7 Sept 07	0.005	0.001	0.204	0.002
C	7 Sept 07	0.047	0.000	0.280	0.002

\* Bq g<sup>-1</sup> refers to dry mass of grass

**Table 2.4(b) Comparison of  $\alpha/\beta$  Activities in Grass with Previous Results**

EM&A Report No.	Mean $\alpha$ Activity (Bq g <sup>-1</sup> )	SU (Bq g <sup>-1</sup> )	Mean $\beta$ Activity (Bq g <sup>-1</sup> )	SU (Bq g <sup>-1</sup> )
1 (Baseline)	0.083	0.044	0.33	0.03
2	0.037	0.012	0.25	0.01
3	0.081	0.017	0.30	0.10
4	0.093	0.009	0.26	0.03
5	0.084	0.020	0.23	0.04
6	0.081	0.056	0.22	0.09
7	0.077	0.046	0.25	0.08
8	0.068	0.047	0.28	0.05
9	0.050	0.023	0.29	0.02
10	0.051	0.008	0.40	0.07
11 (2 <sup>nd</sup> Year)	0.030	0.022	0.27	0.06

2.13 No exceedance of Investigation Level is observed.

**Sea Water**

- 2.14 The same 4 locations were chosen to collect the water samples at 2 depths. The measurement results are given in Table 2.5(a) & (b).
- 2.15 Similar to grass samples, the  $\gamma$  spectra are not reported. There is no sign of presence of  $\gamma$  emitters.
- 2.16 No exceedance of Investigation Level is observed.

**Table 2-5(a) Activity Concentration of Gross  $\alpha/\beta$  Emitters in Sea Water Samples**

Location	Total Depth(m)	Collection Date	Water Level	$\alpha$ Activity (Bq L <sup>-1</sup> )	SD (Bq L <sup>-1</sup> )	$\beta$ Activity (Bq L <sup>-1</sup> )	SD (Bq L <sup>-1</sup> )
A	6.6	7 Sept 07	Surface	#0.00	0.00	2.40	0.13
			Bottom	#0.00	0.00	1.94	0.12
B	7.7	7 Sept 07	Surface	#0.00	0.00	2.38	0.13
			Bottom	#0.00	0.00	2.51	0.13
C	8.9	7 Sept 07	Surface	#0.00	0.00	2.20	0.12
			Bottom	#0.00	0.00	2.55	0.13
D	11.5	7 Sept 07	Surface	#0.00	0.00	2.57	0.13
			Bottom	#0.00	0.00	2.27	0.13

# These activities are below the minimum detectable activity of 1.02 Bq L<sup>-1</sup>.

**Table 2.5(b) Comparison of  $\alpha/\beta$  Activities in Sea Water with Previous Results**

EM&A Report No.	Mean $\alpha$ Activity (Bq L <sup>-1</sup> )	SU (Bq L <sup>-1</sup> )	Mean $\beta$ Activity (Bq L <sup>-1</sup> )	SU (Bq L <sup>-1</sup> )
1 (Baseline)	0.77	0.25	7.20	0.70
2	0.49	0.47	6.10	0.46
3	0.57	0.21	7.43	0.80
4	0.71	0.50	7.00	0.81
5	0.92	0.44	6.15	0.64
6	0.63	0.28	6.99	0.37
7	0.25	0.28	6.30	0.45
8	0.19	0.23	5.84	1.34
9	0.32	0.29	5.21	0.38
10	0.70	0.35	8.35	2.19
11 (2 <sup>nd</sup> Year)	#0.00	0.00	2.35	0.21

**Marine Organisms**

- 2.17 Fishes were caught along the jetty and sea snails were collected randomly along the shores.
- 2.18 The measurement results are given in Table 2.6(a) & (b) and Table 2.7(a) & (b) for the gross  $\alpha/\beta$  activities in fish and sea snails respectively.

**Table 2.6(a) Activity Concentration of Gross  $\alpha/\beta$  Emitters in Fish Samples**

Sample	Collection Date	$\alpha$ Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )	$\beta$ Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )
1	7 Sept 07	0.000	0.000	0.059	0.002
2	7 Sept 07	0.001	0.001	0.065	0.002
3	7 Sept 07	0.000	0.000	0.042	0.002

\* Bq g<sup>-1</sup> refers to wet mass of fish flesh.

**Table 2.6(b) Comparison of  $\alpha/\beta$  Activities in Fish Samples with Previous Results**

EM&A Report No.	Mean $\alpha$ Activity (Bq g <sup>-1</sup> )	SU (Bq g <sup>-1</sup> )	Mean $\beta$ Activity (Bq g <sup>-1</sup> )	SU (Bq g <sup>-1</sup> )
1 (Baseline)	0.0093	0.004	0.068	0.003
2	0.0068	0.004	0.16	0.15
3	0.0116	0.005	0.026	0.006
4	0.0066	0.004	0.065	0.005
5	0.0040	0.004	0.056	0.010
6	0.0069	0.002	0.063	0.002
7	0.0120	0.021	0.047	0.035
8	0.0037	0.002	0.074	0.006
9	0.0100	0.004	0.062	0.050
10	0.0060	0.005	0.078	0.007
11 (2 <sup>nd</sup> Year)	0.0003	0.001	0.055	0.012

- 2.19 No exceedance in Investigation Level is observed.

**Table 2.7(a) Activity Concentration of Gross  $\alpha/\beta$  Emitters in Sea Snail Samples**

Sample	Collection Date	$\alpha$ Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )	$\beta$ Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )
1	7 Sept 07	0.001	0.001	0.045	0.002
2	7 Sept 07	0.000	0.000	0.042	0.002
3	7 Sept 07	0.000	0.000	0.043	0.002

\* Bq g<sup>-1</sup> refers to wet mass of sea snail flesh.

**Table 2.7(b) Comparison of  $\alpha/\beta$  Activities in Sea Snails with Previous Results**

EM&A Report No.	Mean $\alpha$ Activity (Bq g <sup>-1</sup> )	SU (Bq g <sup>-1</sup> )	Mean $\beta$ Activity (Bq g <sup>-1</sup> )	SU (Bq g <sup>-1</sup> )
1 (Baseline)	0.029	0.006	0.064	0.004
2	0.010	0.008	0.034	0.007
3	0.009	0.002	0.032	0.002
4	0.032	0.011	0.050	0.002
5	0.004	0.005	0.045	0.007
6	0.007	0.005	0.042	0.006
7	0.014	0.006	0.063	0.008
8	0.005	0.001	0.040	0.004
9	0.000	0.000	0.023	0.002
10	0.010	0.009	0.045	0.005
11 (2 <sup>nd</sup> Year)	0.000	0.001	0.043	0.002

2.20 All activities are comparable to the baseline levels.

**Airborne Particulates**

2.21 The sampling period was from September 11, 2006 to September 7, 2007.

2.22 Measurement results are given in Table 2.8(a) & (b).

**Table 2.8(a) Net Gross  $\alpha/\beta$  Counts in Airborne Particulate Samples**

Location	$\alpha$ Count-rate (cpm)	SD	$\beta$ Count-rate (cpm)	SD
Blank	0.80	0.12	4.53	0.28
A1	0.25	0.18	1.67	0.44
A2	0.45	0.18	0.33	0.33
B1	0.22	0.06	0.08	0.08
B2	0.00	0.00	0.00	0.00
C1	0.03	0.03	2.10	0.04
C2	0.00	0.00	1.40	0.41

**Table 2.8(b) Comparison of  $\alpha/\beta$  in Airborne Particulate Samples with Previous Results**

EM&A Report No.	A		B		C	
	$\alpha$ (cpm)	$\beta$ (cpm)	$\alpha$ (cpm)	$\beta$ (cpm)	$\alpha$ (cpm)	$\beta$ (cpm)
1 (Baseline)	0.00	0.00	0.00	0.00	0.00	1.17
2	0.09	1.38	0.00	0.39	0.00	0.00
3	0.04	0.45	0.00	1.18	0.13	0.86
4	0.12	1.75	0.65	2.18	0.00	0.28
5	0.35	0.94	0.24	0.66	0.07	0.83
6	0.18	0.33	0.00	0.02	0.00	0.00
7	0.16	0.75	0.16	0.09	0.20	0.00
8	0.84	4.87	0.24	1.64	0.09	1.84
9	0.91	3.03	0.29	1.36	0.09	0.42
10	0.32	1.97	0.11	1.05	0.00	0.03
11 (2 <sup>nd</sup> Year)	0.35	1.00	0.11	0.04	0.02	1.75

2.23 A small amount  $\alpha$  and  $\beta$  were detected, but their activities are comparable to the background.



**3. REPORT ON ELEVATED ENVIRONMENTAL RADIATION BACKGROUND**

- 3.1 The Investigation Levels for environmental samples have been established and they are given in Appendix 1. The relevant action plan is given in the First EM&A Report (Operation Phase).
- 3.2 All samples are below their respective Investigation Levels except the gamma dose rate at Location F which has registered a slight exceedance. The baseline gamma dose rate at Location F is at the low side when compared with measured data throughout the year, so the baseline may have been underestimated.

**4. REPORT ON NON-COMPLIANCE**

4.1 The Action Level and Limit Level (A/L Levels) for non-compliance have been established and they are given in Appendix I for easy reference. The relevant Event and Action Plan have been developed. Please refer to the First EM&A Report (Operation Phase) for details.

**Dose for Radiation Workers**

4.2 There was no record of exceeding the A/L Levels as recorded by TLDs.

**Dose Rates at Un-controlled Areas**

4.3 No exceedance of the A/L Levels was observed.

**Liquid Effluent Discharge**

4.4 There was no liquid effluent discharged during the monitoring period.

**Airborne Effluent Discharge**

4.5 The average total radon released during the monitoring period was estimated to be  $5.4 \times 10^8$  Bq/month, which is below the A/L Levels.

4.6 The discharged  $\alpha$  and  $\beta$  activities were also below the A/L Levels.

4.7 The total airborne effluent discharge was below the A/L Levels.

**5. RESULT OF ENVIRONMENTAL COMPLIANCE AUDITS**

- 5.1 A compliance audit was conducted on November 30, 2007 and no non-compliance was noted.
- 5.2 No compliant was received during the period.

**APPENDIX 1**

**Limit Level and Action Level**

The Limit Levels for non-compliance with the Environmental Performance Requirements during the Operation are shown in Table A1-1.

**Table A1-1 Limit Levels for Non-compliance and Action Levels**

<b>Environmental Performance Requirements</b>	<b>Limit Levels</b>	<b>Action Levels (3/10<sup>th</sup> of Limit Levels)</b>
Dose for radiation workers	1.67 mSv per month	0.5 mSv per month
Dose rate at un-controlled areas	1 µSv per hour	0.3 µSv per hour
Liquid effluent discharge	10 ALI per month	3 ALI per month
Airborne effluent discharge	10 ALI per month	3 ALI per month

**Investigation Level**

With the help of all the internal monitoring, it is unlikely that the effluents will cause any observable increase in the radiation levels in the vicinity of the Facility under normal operation. It is also not anticipated that any significant quantity of the radioactive wastes would be released to the environment under even the most severe natural disasters. Nevertheless when the environmental samples are found to have radioactivities higher than the normal fluctuation of the established baseline levels, some investigation has to be initiated. The levels that trigger the investigation are called investigation levels and they are given in Table A1.2.

**Table A1.2 Investigation Levels for Environmental Samples**

<b>Environmental Samples</b>		<b>Investigation Levels</b>	
Ambient $\gamma$ dose rate ( $\mu\text{Sv h}^{-1}$ )	A	0.23	3 × SD of individual baseline dose rate
	B	0.25	
	D	0.27	
	E	0.29	
	F	0.28	
	G	0.27	
	H	0.31	
	I	0.32	
	J	0.24	
	K	0.32	

	L	0.25	
	M	0.31	
	N	0.29	
	O	0.24	
	P	0.29	
Soil (Bq kg <sup>-1</sup> )	<sup>226</sup> Ra	91.7	3 × SU of baseline samples
	<sup>228</sup> Th	128.5	
	<sup>40</sup> K	1497	
	<sup>137</sup> Cs	1.36	
	Other γ emitters		Occurrence in any quantities
Sand (Bq kg <sup>-1</sup> )	<sup>226</sup> Ra	32.0	3 × SU of baseline samples
	<sup>228</sup> Th	38.1	
	<sup>40</sup> K	894	
	Other γ emitters		Occurrence in any quantities
Grass (Bq g <sup>-1</sup> )	Gross α	0.22	3 × SU of baseline samples
	Gross β	0.43	
	γ emitters not found in baseline		Occurrence in any quantities
Sea water (Bq L <sup>-1</sup> )	Gross α	1.52	3 × SU of baseline samples
	Gross β	9.3	
	γ emitters not found in baseline		Occurrence in any quantities
Fish (Bq g <sup>-1</sup> )	Gross α	0.021	3 × SU of baseline samples
	Gross β	0.076	
Sea snails (Bq g <sup>-1</sup> )	Gross α	0.048	3 × SU of baseline samples
	Gross β	0.076	
Airborne particulates (cpm)	Gross α		Occurrence in any quantities
	Gross β		

- SD is the standard deviation of a single sample.
- SU is standard uncertainty of the sample group.