ATAL-BELGOPROCESS JOINT VENTURE

Contract No. EP/SP/40/02

Low Level Radioactive Waste Storage Facility at Siu A Chau

Seventh Environmental Monitoring and Audit Report (Operation Phase)

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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.

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EXECUTIVE SUMMARY

This report is the last one of the initial 6 monthly EM&A Reports and it presents the results of the radiological monitoring work performed between January 17, 2006 and February 17, 2006. The sampling was done on February 17, 2006.

The LRWF is now operating satisfactorily. The high radon leakage from some of the waste drums has not yet been rectified. A plan has been devised to do a survey of radon leakage of the drums by covering each suspected leaking drum with a special container and then measure the radon emission rate from the drum. Confirmed leaking drums will be reprocessed.

No non-compliance with the environmental performance requirement was observed.

According to the EM&A Manual Part II, subsequent EM&A will be changed to yearly intervals should the initial 6 monthly EM&A Reports indicate no potential problem. It is now concluded that the LRWF is operating satisfactorily according to licence requirement and that no potential problems are foreseen. Hence it is recommended to commission subsequent EM&As in a yearly interval. More details on the concluding remarks and recommendations can be found in Chapter 5.

1. 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 seventh EM&A (Operation Phase) report, which is also the sixth 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 January 17 to February 17, 2006.

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 γ 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 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 γ 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.

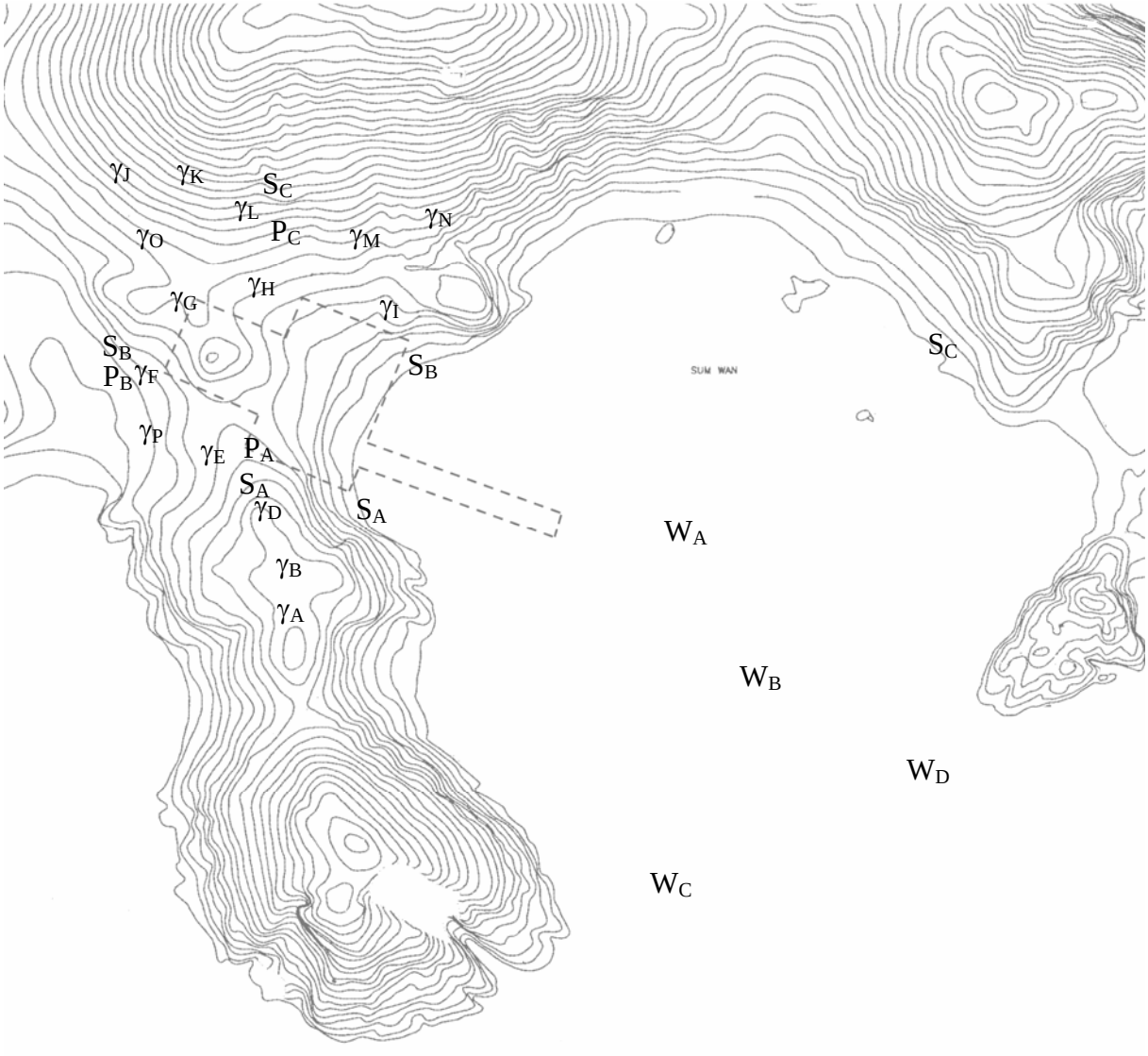

Fig. 2.1 Locations of the Sampling Sites

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

Ambient γ Dose Rates

2.5 Like previous measurements, sloppy sites such as Locations B & L exhibited larger variations.

2.6 It is noted that the dose-rate due to cosmic radiation as measured on the boat was somewhat higher by about 10% in this time than previous measurements. However, the overall average value for the period remains more or less the same.

Soil

2.7 All measurement results were within normal fluctuation range.

Sand

2.8 Sand sample C was consistently showing a higher radionuclide contents than the baseline value since the November sampling. However they are still below the Investigation Level.

Grass

2.9 Grass samples were collected in locations near to the soil samples. The γ-spectra are identical to the background of the γ spectrometer and do not reveal the presence of any significant γ-emitting radionuclides.

2.10 All gross α and β activities are within the normal fluctuation of the baseline values.

Sea Water

2.11 The same 4 locations were chosen to collect the water samples at 2 depths.

2.12 There is no sign of presence of γ emitters.

2.13 All α and β activities are comparable to the baseline levels.

Marine Organisms

2.14 Fishes were caught along the jetty and sea snails were collected randomly along the shores. Only 1 fish was caught in this sampling.

2.15 Both the α and β activities in this fish sample have exceeded the Investigation Level.

2.16 Two more fish were collected on March 31, 2006 to confirm the results. Both the α and β activities of these two fish samples (2 & 3) are normal.

Airborne Particulates

2.17 The sampling period was from January 17, 2006 to February 17, 2006.

2.18 A small amount of α and β were detected, but they are all below the background activity of the cloth itself.

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 A slight exceedance of the Investigation Level was observed for the fish sample. Unfortunately only 1 fish was caught in this survey and no comparison between samples could be made. Because the water samples did not show any abnormal radioactivity and there was no liquid effluent since the operation of the LRWF in August 2005, it is concluded that the exceedance was not attributable to operation of the LRWF.

3.3 Two more fish have been caught to confirm whether there was indeed a raise in radioactivity in fishes. The two new fish samples did not show abnormal radioactivity and did not exceed the Investigation Level.

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 1 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 total radon released during the monitoring period was estimated to be 5.2×10^8 Bq/month, which is below the A/L Levels.

4.6 The discharged α and β 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 The radon emission is under control though the high radon leakage from some of the waste drums has not yet been rectified. A plan has been devised to do a survey of radon leakage of the drums by covering each suspected leaking drum with a special container and then measure the radon emission rate from the drum. Confirmed leaking drums will be reprocessed.

5.2 A compliance audit was conducted on February 20, 2006 and no non-compliance was noted.

5.3 No compliant was received during the period.

5.4 According to the EM&A Manual Part II, the EM&A frequency will be changed to once a year when the initial six monthly EM&As indicate no potential problems. A more detailed analysis of the measurement results are therefore given below and conclusions are also being drawn on whether the EM&A frequency shall be changed to a yearly rate.

Ambient γ Dose Rates

5.5 It is noted that the overall mean γ dose rate for all the 15 locations has not changed during the last 6 months.

5.6 The γ dose rates at individual locations do exhibit some fluctuations. The major reason for recording larger fluctuation is due to the difficulty in positioning the γ dose rate probe at exactly the same spot on a sloppy terrain such as Locations D & L.

5.7 Variation in γ dose rates was also due to actual physical processes done to the surface soils. These could be, for example, addition of grass seeds, addition and ploughing of the soil, addition of fertilizers, leaching due to watering, etc.

5.8 Until the grassland immediately outside the LRWF has been fully restored and vegetation grown, the γ dose rates over those areas may still exhibit fluctuations that are attributable to human activities on the soil.

Soil

5.9 It is evident from previous measurements that the radionuclide contents in different soil samples can differ significantly. It is also apparent that the radionuclide contents at each location have increased gradually with time, particularly for Location B.

5.10 It is difficult to tell whether the observed increase in radionuclide contents was due to gaseous effluent from the LRWF, due to collection of different soil samples at slightly different locations, or due to addition of fertilizers and other planting activities. The only gaseous effluent from the LRWF since its operation was radon and therefore

could not be a contributor for the observed increase in ^{226}Ra and ^{228}Th. Hence the observed increase in radionuclide contents must be due to the latter reasons.

Sand

5.11 Since there was no liquid effluent from the LRWF since its operation on August 2005 and that the monthly monitoring of sea water samples showed no abnormal radioactivity, the observed higher ^{226}Ra and ^{228}Th content in sample C should not be attributable to the operation of the LRWF.

5.12 Radionuclide contents in sand are in general lower than in soil because of leaching to sea water. The higher ^{226}Ra and ^{228}Th content in sand samples therefore might imply the presence of land soil in the sand.

Grass

5.13 The gross α and β activities in grass samples were similar to the baseline values and have remained quite constant throughout the monitoring period.

Sea Water

5.14 Both the gross α and β activities were similar to the baseline values throughout the monitoring period. However, the α activities showed a larger variation and sometimes were not detected.

Fish

5.15 The gross α and β activity in fish samples sometimes showed a slight exceedance in Investigation Level. But since there was no liquid effluent from the LRWF and that water samples did not show any abnormal radioactivity, it is concluded that the exceedance is not attributable to the operation of the LRWF.

5.16 Fish is not a useful bio-indicator in this EM&A because:

a. The fishes do not necessarily live in the bay area.

b. There are many species of fishes and their concentration factors for different radionuclides vary greatly.

Sea Snail

5.17 Both the gross α and β activities were similar to the baseline values throughout the monitoring period.

Airborne Particulates

5.18 Very minute α and β activities were occasionally detected on the cloth samples. This was due to the following reasons:-

a. The collected activities were below the background of the cloth used for collecting the particulates, hence a slight change in the background activity of the cloth will result in some measured net activity.

b. Soil particles were suspended in air by the wind and were collected on the cloth samplers.

c. The cloth sampler did collect suspended radon progenies on the cloth, but the short-lived progenies were allowed to decay before measurements, leaving only the ^{210}Po (a long-lived β-emitter, thus very low radioactivity) on the cloth.

5.19 Since only radon was released from the LRWF during the monitoring period, it is concluded that the collected α and β activities on the cloth samplers were not attributable to the operation of the LRWF.

Conclusions

5.20 There was no liquid effluent throughout the period.

5.21 Apart from the significant amount of radon emitted from the stack, little α- or β-emitters were released. It is noted that remedial actions have been taken to reduce the emission of radon from the waste drums.

5.22 All personnel TLD dose records were close to the background.

5.23 Gamma dose-rates and contamination monitoring carried out inside the LRWF did not reveal any potential problems.

5.24 There was no exceedance of the Action/Limit Levels.

5.25 The appropriate design of the LRWF and the proper use of radiation protection facilities have enabled the LRWF to operate successfully and effectively under the current regulatory constraints. All the environmental performance requirements (dose for workers; dose rate at un-controlled areas; liquid effluent discharge and airborne effluent discharge) are well below the Action/Limit Levels, except the radon emission which is now marginally below the Action Level. After the radon leakage from the leaking drums is rectified, there should be no difficulty for the LRWF to respond to future regulatory demands.

5.26 The database has been properly managed and has been shown to be effective in data retrieval for analysis and decision making.

5.27 No compliant was received so far.

5.28 No accident resulting in release of the stored radionuclides has occurred so far.

5.29 All environmental radiological monitoring results so far did not indicate that the

operation of the LRWF has caused or will cause any adverse effect to the environment.

5.30 It is noted that much human activities have been carried out to restore the vegetations in the vicinity of the LRWF. Such activities have disturbed the monitoring results, particularly the ambient γ dose rates and the soil radionuclide contents.

5.31 Since new surface soil samples were collected every month, the sampling areas have inevitably extended widely and different soil types would have been collected, resulting in significant change in the radionuclide contents.

Recommendations

5.32 Since the radon problem is yet to be resolved, it is recommended that the radiation monitoring scheme internal to the LRWF be maintained at the present schedule.

5.33 The EM&A however is recommended to be changed to a 12 monthly interval because of the following reasons.

a. The initial 6 monthly EM&A do not indicate that the operation of the LRWF has resulted or will result in adverse effect to the environment.

b. No potential problems are foreseen.

c. There are activities being done to restore the vegetations and soil in the vicinity of the LRWF. It is therefore not practical to continue the monitoring in those areas.

d. After switching to a yearly monitoring, the soil samples can then be taken at the same locations, hence the same soil type can be more guaranteed.

5.34 Fishes need not be collected in subsequent EM&As because they not practical bio-indicators.

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

Environmental Performance Requirements	Limit Levels	Action Levels ($3/10^{th}$ of Limit Levels)
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

Environmental Samples		Investigation Levels	
Ambient γ dose rate ($\mu Sv\ h^{-1}$)	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 M N O P	0.25 0.31 0.29 0.24 0.29	
Soil (Bq kg^{-1})	^{226}Ra ^{228}Th ^{40}K ^{137}Cs	91.7 128.5 1497 1.36	3 × SU of baseline samples
	Other γ emitters		Occurrence in any quantities
Sand (Bq kg^{-1})	^{226}Ra ^{228}Th ^{40}K	32.0 38.1 894	3 × SU of baseline samples
	Other γ emitters		Occurrence in any quantities
Grass (Bq g^{-1})	Gross α Gross β	0.22 0.43	3 × SU of baseline samples
	γ emitters not found in baseline		Occurrence in any quantities
Sea water (Bq L^{-1})	Gross α Gross β	1.52 9.3	3 × SU of baseline samples
	γ emitters not found in baseline		Occurrence in any quantities
Fish (Bq g^{-1})	Gross α Gross β	0.021 0.076	3 × SU of baseline samples
Sea snails (Bq g^{-1})	Gross α Gross β	0.048 0.076	3 × SU of baseline samples
Airborne particulates (cpm)	Gross α Gross β		Occurrence in any quantities

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