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28 December, 2023

By Registered Post

EIA Ordinance Register Office, **Environmental Protection Department**, 27/F. Southorn Centre. 130 Hennessy Road, Hong Kong

Attn.: Mr. Simon Ho

Dear Sir.

## Contract No. EP/SP/75/14 Low-Level Radioactive Waste Storage Facility Follow-On Contract FEP-02/131/2002 - EM&A Report (Operation Phase) (Year 2023)

We would like to submit herewith the Environmental Monitoring and Audit Report (Operation Phase) (Year 2023) regarding the operation phase of Low-Level Radioactive Waste Storage Facility at Siu A Chau, which is verified by IEC in November 2023.

A copy of this EM&A Report has been uploaded to our project website: http://www.atal.com.hk/LLRWSF/ for public access.

For any enquiries regarding EM&A matters, please feel free to contact our Mr. Alfred Wong (Tel: 2565 3475, Email: alfredwong@atal.com). Thank You.

Yours faithfully, For and on behalf of ATAL Engineering Ltd.

Alfred Wong **Operation Manager** 

AKOW/DCHS/sthy Encl. (1 copy)

CC. EPD - Mr. Stephen Li

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For the attention of Mr Dicky Siu

28 November 2023

Dear Mr Siu

## Low Level Radioactive Waste Storage Facility at Siu A Chau Independent Environmental Checker Services Environmental Monitoring and Audit Report No. 8 (Operation Phase)

We refer to the email on 13 November 2023 for the submission of the subject report.

We have checked the report and do not have further comments and hereby enclosed this endorsement letter for your onward submission.

If you require any further information, please do not hesitate to contact the undersigned.

Yours sincerely

Franki Chiu

Franki Chiu Independent Environmental Checker

## ATAL ENGINEERING LIMITED

## Contract No. EP/SP/75/14

## Low Level Radioactive Waste Storage Facility Follow-On Contract

Environmental Monitoring and Audit Report No. 8 (Operation Phase)

Version 1.0

October 2023

Prepared and Submitted By	Kay.		
-	(Environmental Team Leader		
	and Responsible Person)		

**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

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### **EXECUTIVE SUMMARY**

This is the eighth Environmental Monitoring & Audit (EM&A) Report for the new Low Level Radioactive Waste Storage Facility Follow-On Contract.

One water sample (Location C, surface water), all fish samples and all grass samples were measured to have  $\alpha$  and/or  $\beta$  activity exceeding their respective Investigation Level (IL). Hence those samples were either recollected or re-prepared for measurement again. Results are now all below the ILs. After reviewing the sample preparation process, it was concluded that those original samples might have been contaminated during the preparation.

The <sup>228</sup>Th activity concentration of Soil A sample has exceeded the IL again. Previous investigation has confirmed that the <sup>228</sup>Th content in the surface soil around that area can vary a lot (see Executive Summary of EM&A Report No. 3), hence no further action was taken.

It was noted that the total release of radon for the past 12 months was much larger than previous years. Investigation revealed that the actual flow rate of radon release before June 26, 2023 should be much lower than the quoted value by about 23%, leading to a much higher calculated total amount of release. June 26 was the date when the current new flow rate was introduced in view of the increased radon concentration in the released gas. To conclude, the total release was still below the A/L level.

The Low Level Radioactive Waste Storage Facility (Facility) has been running smoothly in the past 12 months and no contamination due to the operation of the Facility was observed in the surrounding 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 were stored in disused air raid tunnels close to Queen's Road East in Wan Chai. Other arisings were 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 Low Level Radioactive Waste Storage Facility at Siu A Chau (LLRWSF) for 10 years. Thereafter, the ABJV will transfer the waste management skills for this Facility to Hong Kong.
- 1.4 The LLRWSF was designed to have a storage vault that can initially store 260 drums of waste, each of 275 litres net capacity. The building also contains facilities for waste reception and repackaging, and administering the process. A jetty was built to provide marine access to the Facility.
- 1.5 The Facility is equipped with various radiation monitors 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.
- 1.7 In 2015, ATAL was awarded the contract (Low Level Radioactive Waste Storage Facility Follow-On Contract) to operate the LLRWSF for another 10 years starting from January 19, 2016.

## **Purpose of the Report**

- 1.8 This is EM&A Report No. 8 (Operation Phase) for the Follow-On Contract. This report covers the monitoring period from August 19, 2022 to the date of sampling which was August 15, 2023.
- 1.9 The requirements of the operation phase monitoring and audit, monitoring scheme and monitoring equipment and procedures have been fully described in the EM&A Manual (Part 2). Please refer to that manual for reference.
- 1.10 This report also reports on any non-compliance of personnel doses, dose-rates on nonactive 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 sand samples; 3 grass samples; 8 seawater samples from 4 locations at two depths; 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) (Oct 2005) for details.

Contract No.EP/SP/75/14 Low Level Radioactive Waste Storage Facility Follow-On Contact Environmental Monitoring & Audit Report No. 8 (Operation Phase)



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 y Dose Rates

2.5 The measurement results are given in the last column in **Table 2.1(a)**. The last five years of results are given for comparison. **Table 2.1(b)** shows the mean  $\gamma$  dose rates. It is noted that the overall average value has remained similar during the monitoring period.

			1	Net γ Dose l	Rate (µSv h <sup>-1</sup>	)	
Location	ILs	Baseline (2005)	2018	2019	2020	2021	2022
А	0.17	0.14	0.13	0.15	0.16	0.13	0.14
В	0.19	0.15	0.18	0.13	0.16	0.17	0.16
D	0.21	0.16	0.19	0.17	0.20	0.20	0.16
Е	0.23	0.18	0.14	0.23	0.12	0.17	0.14
F	0.22	0.17	0.14	0.18	0.19	0.18	0.16
G	0.21	0.16	0.19	0.16	0.16	0.18	0.17
Н	0.25	0.20	0.19	0.15	0.14	0.11	0.19
Ι	0.26		0.18	0.18	0.17	0.21	0.20
J	0.18	0.14	0.14	0.12	0.19	0.13	0.17
Κ	0.26	0.21	0.22	0.13	0.18	0.14	0.20
L	0.24	0.19	0.18	0.22	0.19	0.13	0.23
М	0.25	0.20	0.20	0.17	0.19	0.16	0.22
N	0.23	0.18	0.16	0.17	0.17	0.14	0.19
0	0.18		0.13	0.18	0.21	0.19	0.14
Р	0.23		0.20	0.18	0.21	0.21	0.21

Table 2.1(a) Ambient γ Dose Rates at 1 m above Ground

-- Not measured

Location	Па	Net γ Dose Rate ± 1 SD (μSv h <sup>-1</sup> )
Location	ILS	2023
A	0.17	0.15±0.02
В	0.19	0.18±0.03
D	0.21	0.13±0.03
E	0.23	0.13±0.03
F	0.22	0.15±0.03
G	0.21	0.20±0.03
Н	0.20	0.20±0.03
I	0.34	0.19±0.03
J	0.20	0.18±0.03
K	0.26	0.18±0.03
L	0.24	0.20±0.03
M	0.25	0.16±0.03
N	0.23	0.18±0.03
0	0.21	0.14±0.02
Р	0.23	0.14±0.02

EM&A Report No.	Mean Net γ Dose Rate (μSv h <sup>-1</sup> )	SU
Baseline (2005)	0.18	0.026
1 (2016)	0.18	0.022
2 (2017)	0.16	0.021
3 (2018)	0.17	0.028
4 (2019)	0.17	0.031
5 (2020)	0.18	0.025
6 (2021)	0.16	0.032
7 (2022)	0.18	0.032
8 (2023)	0.17	0.026

 Table 2.1(b)
 Comparison of Ambient γ Dose Rates for the past years

2.6 No exceedance of IL was observed.

## Soil

2.7 Soil samples were collected at 3 locations, 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)	<b>Activity Concent</b>	tration of Some <b>N</b>	Major Radionuc	lides in Soil Samples
(ILs for <sup>226</sup> R	a, <sup>228</sup> Th, <sup>40</sup> K and	<sup>137</sup> Cs are respect	ively 155, 218, 2	544 & 2.31 Bq kg <sup>-1</sup> )

Landian	Collection	Activity Concentration (Bq kg <sup>-1</sup> )							
Location	Date	<sup>226</sup> Ra	SD	<sup>228</sup> Th	SD	<sup>40</sup> K	SD	<sup>137</sup> Cs	SD
А	15/8/2023	82.1	1.3	250	1.7	1009	6.1	0.0*	0.3
В	15/8/2023	114	1.4	166	1.6	1052	6.4	0.0*	0.3
С	15/8/2023	56.4	1.2	167	1.5	385	4.2	0.0*	0.2

\* Below minimum detectable activity of 1.86 Bq kg<sup>-1</sup>

Tabla 2 2(b)	Comparison	of Activities in	Soil Sam	nlas for	nast voors
Table 2.2(D)	Comparison	of Activities II	i son sam	pies ior	past years

EM&A Denert No	Mean Activity Concentration (Bq kg <sup>-1</sup> )					
Keport INO.	<sup>226</sup> Ra	<sup>228</sup> Th	<sup>40</sup> K			
Baseline (2005)	85	136	1030			
1 (2016)	101	213	704			
2 (2017)	91.8	165	878			
3 (2018)	82.8	179	774			
4 (2019)	92.2	184	825			
5 (2020)	81.8	170	795			
6 (2021)	74.9	169	801			
7 (2022)	80.3	189	776			
8 (2023)	84.1	194	816			

2.8 The <sup>228</sup>Th activity concentration in Soil A has exceeded the IL.

## Sand

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

Table 2.3(a)Activity Concentration of Some Major Radionuclides in Sand Samples(ILs for 226Ra, 228Th & 40K are respectively 54, 65 & 1520 Bq kg-1)

Turken	Collection	Activity Concentration (Bq kg <sup>-1</sup> )					
Location	Date	<sup>226</sup> Ra	SD	<sup>228</sup> Th	SD	<sup>40</sup> K	SD
А	15/8/2023	29.4	0.8	32.0	0.9	444	3.9
В	15/8/2023	32.0	0.7	34.9	0.8	416	3.6
С	15/8/2023	16.8	0.7	20.8	0.8	478	3.9

Table 2.3(b) Comparison of Activities in Sand Samples for past years

EM&A Report	Mean Activity Concentration (Bq kg <sup>-1</sup> )				
NO.	<sup>226</sup> Ra	<sup>228</sup> Th	<sup>40</sup> K		
Baseline (2005)	31.9	36.7	979		
1 (2016)	26.5	25.3	433		
2 (2017)	27.9	29.5	473		
3 (2018)	30.9	32.6	526		
4 (2019)	28.6	28.3	518		
5 (2020)	37.9	32.9	422		
6 (2021)	25.2	26.6	365		
7 (2022)	26.4	25.2	350		
8 (2023)	26.1	29.3	446		

2.10 No exceedance of IL was observed.

## Grass

2.11 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(ILs for $\alpha$ and $\beta$ activities are respectively 0.22 & 0.43 Bq g<sup>-1</sup>)

Location	Collection Date	α Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )	β Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )
А	15/8/2023	0.012	0.007	0.247	0.027
В	15/8/2023	0.013	0.007	0.284	0.027
С	15/8/2023	0.015	0.008	0.402	0.028

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

## Table 2.4(b) Comparison of $\alpha/\beta$ Activities in Grass for past years

EM&A Report No.	Mean α Activity (Bq g <sup>-1</sup> )	SU (Bq g <sup>-1</sup> )	Mean β Activity (Bq g <sup>-1</sup> )	SU (Bq g <sup>-1</sup> )
Baseline (2005)	0.083	0.044	0.33	0.03
1 (2016)	0.008	0.006	0.24	0.03
2 (2017)	0.006	0.004	0.16	0.04
3 (2018)	0.013	0.003	0.21	0.06
4 (2019)	0.014	0.013	0.17	0.09
5 (2020)	0.027	0.012	0.34	0.09
6 (2021)	0.025	0.006	0.10	0.02
7 (2022)	0.017	0.013	0.32	0.09
8 (2023)	0.013	0.002	0.31	0.08

2.12 No exceedance of Investigation Level was observed.

#### Sea Water

- 2.13 Approximately 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).
- 2.14 Similar to grass samples, the  $\gamma$  spectra are not reported. There is no sign of presence of  $\gamma$  emitters.
- 2.15 No exceedance of Investigation Level is observed.

Location	Collection Date	Water Depth (m)	α Activity (Bq L <sup>-1</sup> )	SD (Bq L <sup>-1</sup> )	β Activity (Bq L <sup>-1</sup> )	SD (Bq L <sup>-1</sup> )
	15/0/2022	1	1.22#	1.3	4.1#	3.1
A 15/8/	13/8/2023	3.5	0#	1.2	2.8#	3.1
р	D 15/0/2022	1	$0.7^{\#}$	1.3	$2.7^{\#}$	3.1
D	13/8/2023	6.5	0#	1.2	3.1#	3.1
	15/0/2022	1*	0#	1.3	4.2#	3.1
	13/8/2023	7.5	0.18#	1.2	4.1#	3.1
D	15/8/2022	1	0#	1.2	2.8#	3.1
	15/8/2023	5	$0.7^{\#}$	1.3	3.8#	3.1

Table 2-5(a)Activity Concentration of Gross α/β Emitters in Sea Water Samples(ILs for α and β activities are respectively 1.52 & 9.3 Bq L<sup>-1</sup>)

<sup>#</sup> Below minimum detectable activity of 2.59 Bq L<sup>-1</sup> for  $\alpha$  and 4.54 Bq L<sup>-1</sup> for  $\beta$ \*Surface water at Location C was re-collected for measurement on 4/9/2023

EM&A Report No.	Mean α Activity (Bq L <sup>-1</sup> )	SU (Bq L <sup>-1</sup> )	Mean β Activity (Bq L <sup>-1</sup> )	SU (Bq L <sup>-1</sup> )
Baseline (2005)	0.77	0.25	7.20	0.70
1 (2016)	0.00	0.00	2.66	2.63
2 (2017)	0.00	0.00	1.97	2.32
3 (2018)	0.00	0.00	1.01	0.98
4 (2019)	0.00	0.01	2.47	1.65
5 (2020)	0.06	0.09	5.29	0.61
6 (2021)	0.20	0.26	6.56	1.50
7 (2022)	0.42	0.44	6.14	1.46
8 (2023)	0.35	0.47	3.44	0.67

Table 2.5(b) Comparison of  $\alpha/\beta$  Activities in Sea Water for past years

## **Marine Organisms**

- 2.16 Fishes were caught along the jetty and sea snails were collected randomly along the shores.
- 2.17 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 (ILs for  $\alpha$  and  $\beta$  activities are respectively 0.021 & 0.076 Bq g<sup>-1</sup>)

Sample	Collection Date	α Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )	β Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )
1	4/9/2023	0.002#	0.004	0.047	0.019
2	4/9/2023	$0.000^{\#}$	0.004	0.059	0.019
3	4/9/2023	0.000#	0.005	0.076	0.020

\* Bq  $g^{-1}$  refers to wet mass of fish flesh. # Below minimum detectable  $\alpha$  activity of 0.008 Bq  $g^{-1}$ .

Table 2.6(b) Comparison of $\alpha/\beta$ Activities in Fish Samples for past year	rs
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EM&A Report No.	Mean α Activity	SU	Mean β Activity	SU
	(Bq g <sup>-1</sup> )	( <b>Bq g</b> <sup>-1</sup> )	( <b>Bq g</b> <sup>-1</sup> )	(Bq g <sup>-1</sup> )
Baseline (2005)	0.0093	0.004	0.068	0.003
1 (2016)	0.0077	0.008	0.014	0.005
2 (2017)	0.0000	0.000	0.055	0.012
3 (2018)	0.0000	0.000	0.032	0.032
4 (2019)	0.0000	0.000	0.029	0.010
5 (2020)	0.0020	0.000	0.046	0.010
6 (2021)	0.0034	0.003	0.049	0.007
7 (2022)	0.0000	0.000	0.062	0.010
8 (2023)	0.0007	0.001	0.061	0.015

2.18 There is no exceedance of IL.

	-				
Sample	Collection Date	α Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )	β Activity* (Bq g <sup>-1</sup> )	SD (Bq g <sup>-1</sup> )
1	15/8/2023	0.001#	0.005	0.070	0.019
2	15/8/2023	0.001#	0.005	0.070	0.019
3	15/8/2023	$0.000^{\#}$	0.004	0.049	0.019

Table 2.7(a) Activity Concentration of Gross α/β Emitters in Sea Snail Samples (ILs for  $\alpha$  and  $\beta$  activities are respectively 0.048 & 0.076 Bq g<sup>-1</sup>)

\* Bq g<sup>-1</sup> refers to wet mass of sea snail flesh. # Below minimum detectable  $\alpha$  activity of 0.008 Bq g<sup>-1</sup>.

Table 2.7(b) Comparison of $\alpha/\beta$ Ac	tivities in Sea Snails for past years
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EM&A Report	Mean α Activity	SU	Mean β Activity	SU
No.	(Bq g <sup>-1</sup> )			
Baseline (2005)	0.029	0.006	0.064	0.004
1 (2016)	0.001	0.001	0.025	0.016
2 (2017)	0.003	0.001	0.017	0.002
3 (2018)	0.002	0.002	0.048	0.012
4 (2019)	0.005	0.005	0.041	0.002
5 (2020)	0.004	0.002	0.040	0.009
6 (2021)	0.005	0.002	0.039	0.016
7 (2022)	0.000	0.000	0.052	0.012
8 (2023)	0.007	0.001	0.063	0.012

2.19 No exceedance in Investigation Level is observed.

#### **Airborne Particulates**

2.20 The measurement results are given in Table 2.8(a) & 2.8(b).

## Table 2.8(a)Net Gross α/β Activities in Airborne Particulate Samples<br/>(ILs are not defined)

Location	Collection	a Activity	SD	β Activity	SD
	Date	(Bq per 1000 cm <sup>2</sup> )		(Bq per 1000 cm <sup>2</sup> )	
Blank		0.09	0.02	9.33	0.01
A1	15/8/2023	0.82	0.20	3.37	0.56
A2	15/8/2023	0.30	0.17	2.97	0.56
B1	15/8/2023	$0.18^{\#}$	0.16	1.19	0.55
B2	15/8/2023	0.72	0.20	1.83	0.56
C1	15/8/2023	0.66	0.19	1.59	0.55
C2	15/8/2023	0.16#	0.15	2.30	0.55

<sup>#</sup> Below minimum detectable  $\alpha$ -activity of 0.30 Bq per 1000 cm<sup>2</sup>

# Table 2.8(b) Comparison of $\alpha/\beta$ in Airborne Particulate Samples for past years (Units in Bq per 1000 cm<sup>2</sup>)

EM&A Report	A		I	В		С	
No.	α	β	α	β	α	β	
Baseline (2005)	0.00	0.00	0.00	0.00	0.00	0.13	
1 (2016)	0.00	0.46	0.00	0.34	0.00	0.17	
2 (2017)	0.03	0.37	0.01	0.26	0.04	0.27	
3 (2018)	0.11	1.33	0.13	0.59	0.13	1.25	
4 (2019)	0.04	0.36	0.05	0.57	0.04	0.18	
5 (2020)	0.07	0.79	0.15	0.56	0.01	0.09	
6 (2021)	0.07	1.03	0.05	0.52	0.10	0.64	
7 (2022)	0.63	1.76	0.14	0.42	0.14	0.18	
8 (2023)	0.56	3.17	0.45	1.51	0.41	1.95	

2.21 All activities are normal.

## 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) (Oct 2005).
- 3.2 There is no evidence that the environmental radiation background has been elevated.

#### 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) (Oct 2005) 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 8.6 x  $10^8$  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. RECORD OF ENVIRONMENTAL COMPLAINTS

5.1 No environmental 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**.

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

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

Environmental Samples		Investigation Levels	
	А	0.17	
	В	0.19	
	D	0.21	
	E	0.23	
	F	0.22	
	G	0.21	
Net Ambient γ dose	Н	0.21	$3 \times SD$ of
rate	Ι	0.34	individual baseline
$(\mu Sv h^{-1})$	J	0.20	dose rate
	К	0.26	
	L	0.24	
	М	0.25	
	Ν	0.23	
	0	0.21	
	Р	0.23	
Soil (Bq kg <sup>-1</sup> )	<sup>226</sup> Ra	155	
	<sup>228</sup> Th	218	$3 \times SU$ of baseline
	<sup>40</sup> K	2544	samples
	<sup>137</sup> Cs	2.31	1

 Table A1.2
 Investigation Levels for Environmental Samples

	- 1		
	Other γ		Occurrence in any
	emitters		quantities
Sand	<sup>226</sup> Ra <sup>228</sup> Th <sup>40</sup> K	54.4 64.8 1520	3 × SU of baseline samples
	Other y emitters		Occurrence in any quantities
Grage	Gross α Gross β	0.22 0.43	3 × SU of baseline samples
$(Bq g^{-1})$	γ emitters not found in baseline		Occurrence in any quantities
Sao watar	Gross α Gross β	1.52 9.3	$3 \times SU$ of baseline samples
(Bq L <sup>-1</sup> )	γ emitters not found in baseline		Occurrence in any quantities
Fish (Bq g <sup>-1</sup> )	Gross α Gross β	0.021 0.076	$3 \times SU$ of baseline samples
Sea snails (Bq g <sup>-1</sup> )	Gross α Gross β	0.048 0.076	$3 \times SU$ of baseline samples
Airborne particulates (Bq per 1000 cm <sup>2</sup> )	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.