

PROGRESS IN LOW-AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE DISPOSAL IN CHINA

Qu Zhimin, Sun Donghui
Everclean Environmental Engineering Corp., CNNC

ABSTRACT

The policy and principles on management of Low-and Intermediate-Level radioactive wastes have been stipulated in China. According to the regional disposal policy of L/ILW in near surface, which has been approved by Chinese government, One disposal repository is being constructed and another will be put into operation this year. Site characteristics and parameters of these two repositories will be given.

INTRODUCTION

In China, disposal of low-and intermediate-level radioactive wastes involves the policy of •regional disposal•. Four repository have been planned to be built in northwest, southwest, south and east China respectively while the northwest and south repositories are being constructed.

LAWS, REGULATIONS AND FRAMEWORK OF STANDARDS FOR RADIOACTIVE WASTE DISPOSAL

Since 1987 when the drafting began, the law on Radioactive pollution prevention has been finalized after repeated discussions and amendments. This is a basic law on radioactive management and this document will be subject to approval by the Standing Committee of the National People's Congress. The Policy and Principles on Disposal of Low-and Intermediate-level Radioactive Solid Waste was promulgated in 1992 and approved by the State Council, dealing with the matters in disposal of solid low-and intermediate-level radioactive waste(L/ILW), and the site selection, construction and operation of the disposal facilities under the liability of the China National Nuclear Corporation (CNNC), and the activities of regulatory control under the liability of the state Environmental Protection Administration (SEPA). The criteria related to Low-and Intermediate-level radioactive waste disposal, such as waste acceptance and package criteria, have been issued.

Table 1 shows some typical laws and regulations in use or under preparation.

Table 1. Laws and Regulations issued and under Preparation

Title	Approval unit	Status
The law on Radioactive Pollution Prevention	SCNPC	Under preparation
The Policy and Principles on Disposal of Solid LILW	State Council	In use
The Principles for Radioactive Waste Management	State Council	Under preparation

Table 2 . shows the criteria for radioactive waste management which were issued or are under preparation, and the titles of these documents are listed in the Attachment 1.

Table 2. Criteria on Radioactive Waste Management

Types	In use	Under preparation	In planning
General Criteria	4		
Waste Sources and Release Control	3		2
Collection and Treatment	4	2	2
Volume Reduction	1		
Solidification	4		
Package	1	2	2
Storage	4		
Transport	3	1	1
Disposal	3	6	
Milling of Uranium and Thorium	5		

RADIOACTIVE WASTE MANAGEMENT ORGANIZATION

State Environmental Protection Administration (SEPA) is in charge of the centralized management of radwaste in China. Its main tasks are:

- Establish a state planning of radwaste management;
- Issue the regulations, rules and standards concerning radwaste management;
- Review and approve the environmental impact and safety analysis reports;
- Issue the license for nuclear installations;
- Exercise nuclear safety surveillance, and
- Inspect the activities of nuclear facilities and the environment status.

China National Nuclear Corporation (CNNC) has the responsibility for its own radwaste management; otherwise, CNNC is authorized to draft most of the regulations, rules and standards regarding with radiation protection, radwaste management and nuclear safety.

Everclean Environmental Engineering Corp. (EEEC), one of the subsidiaries of CNNC, is authorized to be in charge of siting, construction and operation of L/ILW repositories and transport of spent fuel and radwaste in China.

THE NATIONAL PROGRAM AND PROGRESS IN LOW-AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE DISPOSAL IN CHINA

In compliance with the national policy of radioactive waste disposal, the SEPA approved the disposal sites constructed in Northwest China and South China in 1994 and in 1995. Investigation for the site selection in East China is being conducted now. In conformity with the Policy and Principles on Low-and Intermediate-level Radioactive Solid Waste approved by the State Council, a radioactive waste management company, Everclean Environmental Engineering Corporation, was founded under the CNNC by the end of 1994 with particular responsibility for radioactive waste disposal.

The disposal site selection in the northwest part of China was initiated in 1988. Based on the geological survey 6 candidates were recommended. Further analysis led a final decision in favor of the Gobi Desert where no population and no river found within 10km away from the site and ground water 30-50 m below the ground. The Environmental Impact Report on L/ILW Disposal Site for the Gobi Desert Site, and the SEPA's review were completed in 1993. When the preliminary design of the site was completed, construction design has been launched. The designed capacity is about 200,000 cubic meters, with the first phase project being 20,000 cubic meters. Near surface disposal methodology is employed, the disposal cell built with reinforced concrete. Surface cover includes layers of soil, clay, sandy gravel layer and mixed soil and gravel. The first phase project has been completed last year.

The selection of the disposal site in South China began in 1991. Based on the area investigation, 37 potential sites are recommended. After analysis, 20 of them were determined for further geological survey to ascertain the site characteristics such as specific location, traffic conditions, topography and geomorphic, site size, stratum lithology and geological formation as well as the conditions related to hydrology, engineering, geology and ecology. On the basis of analysis and comparison, 3 sites were selected for detailed investigation, including hydrogeological and geological prospecting by drilling 64 holes, and distribution coefficients of typical soils calculated for the two of the 3 sites. The finalized disposal site was to be constructed at Beilong near the Guangdong Daya Bay Nuclear Power Station. It is expected to accommodate 80,000 cubic meters of wastes. For the first phase project, planned to be completed in 1999,

8,800 cubic meters of wastes can be accommodated as estimated, future enlargement up to 240,000 cubic meters considered.

The siting of the disposal site in East China has been started. At present, two candidate sites are investigated for final determination. One of them is a cave disposal site, another one is a shallow ground disposal site. It is planned the site selection will be finished around 2000.

Hydraulic fracturing press of L/ILW was put into operation in 1997. Bulk concrete casting treatment of intermediate-level radioactive liquid waste is in the process of engineering implementation.

SITE CHARACTERIZATION OF I/LLW REPOSITORIES

Site characterization is the most important stage for selecting a suitable site for disposal facilities from the safety point of view, since in this stage some investigations of potential sites have to do and to establish the characteristics and the parameters required for the intended disposal site.

Some characteristics of North-West disposal site

North West disposal site for L/ILW is located at Gobi desert in Gansu Province with very low population density. There are no residential area in 10km limited and potential valuable resources. There are railway and road nearby.

A. Meteorology

The site area is a typical temperate zone continental dry climate area. The precipitation is low, most of the rainfall is in June to August but the evaporation is high. Table 3 shows the main parameters of the meteorology.

Table 3 Main parameters of the meteorology
of North-west disposal site area

Annual average precipitation	61.5mm
Annual average evaporation	3577.1mm
Annual average relative humidity	36%
Max. Precipitation per day	25.7mm
Max. temperature	38.2•
Min. temperature	-28.1•
Max. ground temperature	64.7•

B. Hydrogeology

Since the dry climate, the vegetation is underdeveloped. The water retention of the earth's surface is low, so the ground water is poor in this area. The water table is in range of 28m to 30m and no distinct change: The groundwater discharges mainly through spring's or runoff. The nearest outcropping point is located at far seat-north direction.

The PH and total dissolved solids of the groundwater is quite stable they are PH=8 and 3.30•6.89g/l.reapectively. There are no erosive CO₂ inspected, but the concentration of the SO₄²⁻ is higher (397.4•489.6mg/l). Because of the deep water table, the concrete of the building will not be eroded.

C. Lithology and geotechnical characteristics .

The main characteristics of the sitelitheatiatigraphy are shown in table 4.

Table 4. Main characteristics of North-west site lithostratigraphy

stone or soil	Dry deasity (g/cm ³)	Moisture content (%Vol.)	K• (cm/min)
Siltstone soil	1.42	2.5•42.5	2.7•10 ⁻⁶ •5.14•10 ⁻³
clay	1.78	2.2•44.0	1•10 ⁻²⁵ •2.9•10 ⁻³
Fine sand soil	1.73	7.62•37.68	3.58•10 ⁻⁸ •2.01•10 ⁻²
conglomeratic sand soil	1.94	5.65•34.32	4.8•10 ⁻⁵ •5.45•10 ⁻²

Table 5 shows the distribution coefficient (Kd) of some radionuclides

Table 5 Distribution coefficient of nuclides

Nuclides	Sr-90	Cs-137	Ni-63	Pu-239
Kd	0.73	58	361	2026

D. Tectonics and seismically

In disposal site area there are 5 faults ,but they are far some distance of the site ,not across the site ,and all of them are incapable faults.

The site area is located in Hexi Corridor earthquake zone.

There are few recent or historic earthquake records in 50km radius limits. Since 1400 the period of the earthquake with Ms•6 is about 160 years. The disposal building is designed with fortification of earthquake intensity 8.

E. Evaluation of the North-west site suitability

It is the conclusion of the evaluation, that the North-west disposal site is a very good site of repository for LILW, since:

- a) it is located in a stable area .All the faults nearby are incapable.
- b) The terrain of the site is smooth, the precipitation is very low and the water table is deep. There are no potential damages of erosion and pounding accrued by flood or groundwater.
- c) There are more than 50m different clay layers, they possess better sorption capability which can resist the migration and diffusion of the nuclides, meanwhile. they are also good isolation lay form groundwater.

Some characteristics of Beilong disposal site

Beilong disposal site is located at east-north of Dapun peninsula in Guangdong Province, about 5 km far from Daya Bay NNP. It sits with peiya hill behind and the Daya Bay front. It is a seaside and lower hilly land area.

Beilong site's area is about 0.205km². The elevation of the site ground is 44.6m. There is a road which lands to Daya Bay NPP and Lingao NPP. Daya Bay possesses two quails, so the sea transport is quite convenient.

There are no residential area in 3 km radius limits.

A. Meteorology

It is opposite to North-West disposal site, this area is a typical south-Asia tropical monsoon climate. The precipitation is abundant and the temperature is high. Table 6 shows the main parameter of the meteorology.

Table 6 Main parameters of the meteorology
of the Beilong disposal site area

Annual average precipitation	1900mm
Annual average evaporation	1641mm
Average relative humidity	69%•86%
Max. precipitation per day	219.2mm
Max temperature	38.4•
Min temperature	2.3•
Max ground temperature	64.3•
Max wind velocity	79m/s

B. Hydrogeology

Surface water

There are two rivulets beside the disposal site flowing to Daya Bay. There are main discharge say for surface water and groundwater in site area. North of the site is Lingao reservoir, some data are given in table 7.

Table 7 Some data of Lingao reservoir

Dam type	Homogeneous soil dam
Elevation of the dam top	85.59m
Designed water level	83.70m
Length of the dam top	500m
Total capacity	5.96Mm ³

The results of the engineering geological investigation and coalition show:

- a) the max. holding water in the reservoir has no obvious effect to groundwater level of the site;
- b) in case of burst, the highest inundation level will be 43.6m, lower than ground level 44.6m.

Ground water

The groundwater table is between 5m to 15m. It can change very closely with rainfall, Normally in march the level is high , in June, July and August low.

The total dissolved solids of the groundwater is between 41.78mg/l to 177.76mg/l, PH=5.2•6.6, erosive CO₂ •30mg/l, Main anions in groundwater are HCO₃⁻and Cl⁻, main cautions are Ca²⁺ and Na⁺, so it needs to use some anti-acid measures to protect the engineering structure.

C. Lithology and geotechnical characteristics

The main characteristics of the site lithostratigraphy and distribution coefficient of nuclides are shown in table 8 and table 9 respectively.

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Table 8 Main characteristics of the Beilong site lithostratigraphy

stone or soil	Dry density (g/cm ³)	Moisture content (%Vol.)	K• (cm/min)
silt soil	1.67	20.5	$1.7 \cdot 10^{-3}$
silt clay	1.50	28.28	$4.2 \cdot 10^{-2}$
Strong weathered metamorphic site stone	1.66	22.9	$6.1 \cdot 10^{-3}$
Strong weathered metamorphic fine sand stone	1.77	14.1	$1.7 \cdot 10^{-4}$

Table 9. Distribution coefficient of nuclides

Nuclides	Sr-85	Cs-134	Ni-63	Pu-239	Co-60
Kd(ml/g)	425.4	2800	15.7	120.4	531.7

D. Tectonics and seismically

The outcropping stratum is medium deviation guitar group upper subgroup (D_{2g}^b) and quaternary period (Q) in site area. The faults in the area are developed, but individually and small. There are no active fault in the area. All the vaults (80000 m³ capacity) will build on the field that there are no faults across it.

The disposal site is located on south-east coast earthquake zone, but it is a lower earthquake zone. In 100km radius limits there was no higher than 6 magnitude earthquake occurred, so it is a crustally stable area.

E. Evaluation of the Beilong site suitability

- Disposal site is located on a stable stratum, in 20 km radius limits there are no active faults. All 4 small cracks are incapable.
- The hydrogeological conditions are relative simple. The disposal site is located at groundwater watershed, two rivulets can discharge the water into the sea.
- Lingao reservoir will not affect the disposal facility.
- It is a relative closed area, less population, no large scale industrial facilities, expect NPP.

So it is suitable disposal site for L/ILW.