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The lessons learned from Andra's Experiences on the Leachate Collection System of the Surface Disposal Facility

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1. Introduction

Nuclear waste disposal is a subject of concern for the nuclear waste management. One of the solutions planed to take care of nuclear wastes is surface or near-surface disposal repository which is experienced by many other countries including Andra in France (the French Radioactive Waste Management Agency). In particular Andra has developed this type of repository reflecting many years of experiences of operation and management of the facility. Andra's Centre de l'Aube has been used as a reference model for the surface disposal of radioactive waste by many countries worldwide[1]. But, the detail design of this type of facility needs to be improved and developed suitably for local characteristics taking into account the radioactive waste properties, local site environment and regulatory requirements in each country.

The main design scenario to handle radioactive material in surface or near-surface radioactive waste disposal facility is that the radioactive nuclides are leached from waste by dissolving into rainwater passed through the disposal cover and concrete slab, and the infiltrated rainwater with radioactive nuclides flows to the aquifer through the concrete mat and the vadose zone, finally they are reached east sea through the aquifer or fault zone according to the hydro-geological characteristics of the site. The design concept to tackle this scenario and to deal with infiltrated and rain water in the surface disposal facility is described herein. This paper is based on the lessons learned from Andra's experiences especially on the drainage system which are given in the references[1, 2, 3]. This paper also presents key items which need to be looked into for the local design which might be adopted at the second phase of LILW disposal facility at Wolsong.

2. Separative Water Collection Systems

Surface or near-surface radioactive facilities may use the geology such as a low permeability geosphere and rock structure to provide an environmental safety function, but some may rely largely on engineered barriers to augment natural barriers. Each barrier is designed to fulfill different or redundant functions in order to delay or mitigate radionuclide transfers first into the environment and onwards to human beings[2]. In this section, the Infiltration and rainwater collection system design and related piping layout is intensively described, which is one of the man-made barriers also known as the EBS(Engineered Barrier System), coming from study of Andra's facility which is located above the water table.

2.1 Infiltration Water Collecting System

One of the EBSs is to collect radioactive waste or doubtful water from disposal vaults as degradation of the concrete vault is going on. This has to be done separately from collecting rain water which has no possibility to be contaminated. This activity involves waste process management, waste tracking, data & information communication, monitor effluents. And this is a part of providing protection to the human health and environments from potential contamination. Infiltration water collecting system is disposed on the vault slab where the collector, FD(Floor Drain), is at the lowest point. The FD is connected to the infiltration water collection system. The main function of this system is to collect leachate which might be contaminated by contacting the radioactive wastes. The system is independent due to the physical separation between infiltration water and rain water. In other word, the water from empty vault goes to the rainwater drainage system whereas the water from a vault in operation and filled vaults goes to the infiltration water collection system as shown in the Fig. 1.

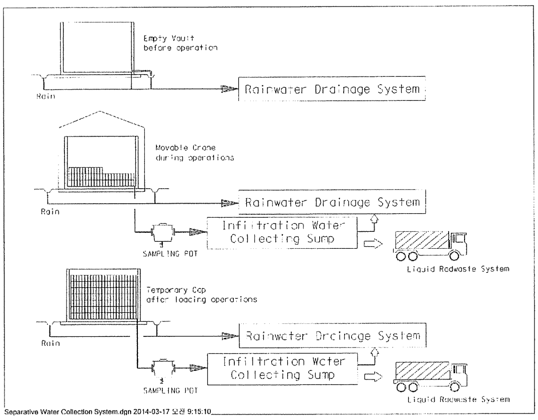

Fig. 1. Separative Water Collection System in the surface disposal facility (l'Aube Facility)

The system is composed of FD, sampling pot and related pipe lines. They are all laid out in the underground galleries which are used for management of rainwater, infiltration water coming into disposal vaults and for the inspection & maintenance of vault floors. Infiltration water pipeline has to be about 1% slope towards infiltration water collecting tank which is located at the end of underground main gallery. Therefore the infiltration water runs by gravity without any electric power.

2.2 Rainwater Collecting System

The rainwater collecting system is also one of the EDBs to be established to minimize the infiltration water into the disposal vaults. Namely, measures should be taken to evacuate rapidly the amount of rainwater penetrating the cap and vault concrete. This enables minimization of the possibility of contacting the rainwater with radwaste resulting in subsequent release of radionuclides. The rain water from vaults before operation needs to be drained through a separate pipeline shown in Fig.1.

Following is a Table shown 100 year recurrence interval rainfall intensity at Wolsong province, which should be considered for the design of rainfall drainage system [4].

Table 1. 100 year recurrence interval rainfall intensity

Rainfall continuous Hour (min.)	10	30	60	360	1440
Rainfall intensity (mm/hr)	154.7	101.9	78.3	39.6	23.4

From the above table, the magnitude of design precipitation at the site for the use of rainfall drainage design parameter is 78.3mm of 1-hour maximum precipitation.

An interesting point is found in the l'Aube facility design for another rainwater outlet. This seems to take into account specific condition of heavy rainfall situation at short period of time. In case of heavy rainfall at the site during short time, a great quantity of rainwater can be evacuated through the temporary openings on the vault walls, which are connected to rainwater drainage circuit (ditch) outside disposal vaults rather than through floor drainage system. The same case can be introduced for the Wolsong site. Taking into account 10 minutes rainfall intensity (154.7mm/h) at site another means, the temporary opening as shown on the Fig.1, should be paralleled with drainage system through the FD to evacuate heavy quantity of rainwater quickly.

Floor drain may need to be blocked with rubber or something during before operation so that the entire rainwater can be drained out. This option may show much benefit by making it possible to eliminate rainwater drainage pipeline in the underground gallery.

2.3 Calculation of pipe size for Infiltration & Rainwater drainage system

There are many parameters to be considered to calculate the size of infiltration pipeline from each disposal vault such as local precipitation, climate condition, the vault unit area, slope per unit length of pipeline, the recommended velocity of running fluid and infiltration rate above all things, etc. The quantity of flow and flow speed in the pipeline are also parameters to consider. The infiltration rate depends primarily on the degradation of the vault concrete and multi-layer cap caused by cracks, corrosion and root intrusion, etc.

The size of rainwater pipeline also needs to be calculated properly considering many parameters such as the quantity of fluid, precipitation data, slope of pipeline, etc. The future detail design would show these figures for the pipeline sizes so that the size of underground gallery is appropriately designed.

2.4 Monitoring pot on the infiltration pipeline

The infiltration pipeline system constitutes a separative gravity network which collects any infiltration water that may migrate through the disposal concrete. The sampling pot from which the fluids are sampled for monitoring needs to be put in this network and the fluids would direct it towards an external liquid radioactive treatment plant, if contaminated. This would be a primary part of radiological monitoring program carried out for the environmental safety of the facility during operation and even institutional control period. The sampling pots need to be located on the pipeline from each disposal unit and each row of disposal units. This enables operator to identify where radioactive nuclides come from, if any.

3. Conclusions

It is widely known that Andra has demonstrated that low and intermediate level of waste can be managed in a safe and efficient manner and disposed of surface level of ground. This paper has reviewed upgraded EBSs evolved by Andra's many years of experiences, especially the measures to deal with drainage system which is available information online published to the public. The system has been improved with underground galleries which enables sampling and monitoring with ease.

One goal of this study is to understand the essential drainage system in the surface disposal facility and another goal to know what needs to be improved, which should be compatible with a specific site in Korea. Since the actual technology which needs to be applied will be specific to each site.

REFERENCES

[1] IAEA-SM-357/27, Andra's Centre de L'Aube: Design, Construction, Operation of a State of the Art Surface Disposal Facility for Low and Intermediate Level Waste
[2] Andra, The surface disposal concept for LIL/SL waste.
[3] Historical Background of the Operation, Closure and Monitoring of Andra's CSM Disposal Facility.
[4] LILW Disposal Facility, GDC (Design Criteria Manual), Doc. No: 1-037-B401-001, Rev.2