XA0300173

IAEA-CN-90/44

PROGRESS OF THE RADIOACTIVE WASTE MANAGEMENT AT THE DALAT NUCLEAR RESEARCH INSTITUTE AND THE ROLE OF AN IAEA TECHNICAL CO-OPERATION PROJECT IN THIS PROCESS

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Abstract

At present, the main radioactive waste generator in Vietnam is the Dalat Nuclear Research Institute (DNRI). For safe management of radioactive waste generated from this nuclear center, in 1982 Soviet specialists newly constructed one combined technology system for low level radioactive waste management. The existing system consists of two main parts, a Liquid Radioactive Waste Treatment Station and a Storage/Disposal Facility. The liquid treatment station can in principle meet the needs for this nuclear center but disposal technology and storage/disposal facilities are not good enough both with respect to safety and economy, especially the storage/disposal facility placed in Dalat, the tourist city. In order to help DNRI and Vienam to solve the radioactive waste management problem, the IAEA Technical Co-operation (TC) project VIE/9/007 was implemented in Vietnam. The facilities and IAEA experts provided under this project gradually help to develop radioactive waste management at DNRI, Voietnam. This paper outlines progress under way in the management of the radioactive waste at the Nuclear Research Institute (NRI), Dalat, Vietnam, and the role of the IAEA Technical Co-operation (TC) project in this process.

1. Introduction

The DNRI is equipped with a system for radwaste management based on the former USSR regulation valid at the beginning of the eighties. The solid waste treatment procedure and disposal technology of the radwaste were not satisfactory from the point of radiological safety, particularly since the disposal site is a tourist city. Therefore, the main purpose of the research and development activities in the field of the radwaste management is to find out the way, how to apply world radioactive waste management technology to DNRI.

In the first ten years of reactor operation, the solid waste could not be treated and conditioned in the right way due to lack of main facilities and equipment. After an IAEA WAMAP Mission had visited Vietnam, recognizing and sharing the radwaste difficulties, a new IAEA technical co-operation (TC) Project VIE/9/007 was implemented in Vietnam from 1994 to 1999. The facilities and IAEA-Experts provided under this project helped to solve problems such as solidifying of the liquid/sludge waste, characterizing, segregating, compacting and conditioning of the solid radwaste that had not yet been settled before. These activities enabled to manage the radwaste at DNRI in the proper way. The paper presents the progress made in the development of the radwaste management at DNRI and the impact of the IAEA TC Project in this process.

2. Radioactive waste generated

2.1. Liquid waste

The main quantity of the radwaste from DNRI is in liquid form. Each month the entire institute generated about $15m^3$ - $20m^3$ of aqueous liquid waste, with a total gamma and beta radioactivity of less than 3.7 KBq/l and a surface dose rate less of than 5mR/hr. The liquid radwastes are characterized by two cases. The first case, 'simple' composition, is the result of the research reactor operation, while the second one 'difficult' is resulting from radioisotope production and other physical-chemical laboratory activities. The characteristics of the liquid waste and the treatment station are described in detail in paper [1].

2.2. Solid radwaste

Recently, all solid radwastes generating from DNRI and some Nuclear Medicine Departments in the South of Vietnam are collected in the storage/disposal facility. They are then pre-treated and conditioned. According to the IAEA classification for radwaste [2] most of them belong to low level, short-lived radwaste. They contain principally the following nuclides: P-32, Co-60, Eu-152, Cr-51, Cs-134, Fe-59, Mn-54, I-131 with average total gamma and beta activities of less than 1,000 Bq/g and a surface dose of less than 50mR/hr. More than 75% of them are compactible radwaste.

3. Research and development in the treatment and conditioning technique for radioactive waste at DNRI.

3.1. Research to choosing optimal method for treatment of aqueous liquid waste

In the first years (1984-1990), the liquid waste treatment station was operated according to the design procedure. The raw liquid radwastes were treated by chemical precipitation, mechanical filter and two stages of ion-exchanger [1]. This method is safe but not economic because of high cost in the processing and conditioning. It was investigated, how to treat liquid waste not only safely but also in an economic way. From the research results, three methods were successfully carried out. These procedures are summarized as follows:

1. Raw liquid waste→Mechanical filter→first stage ion-exchange→Control tank (CT).
2. Raw liquid waste→Precipitation→Mechanical filter→first stage ion-exchange→CT.
3. Raw liquid waste→chemical precipitation→Mechanical filter→Two stage ion-exchange→CT.

The procedure (1) is applied to collecting tank, characterizing the simple component.
The procedure (2) is used for liquid waste with low salt content but high of oxygen demand.
The method (3) is applied to liquid waste tank, characterizing the difficult component.
The total gamma and beta activity after treatment is less than 3.7 Bq/l (pH =5-9). After control, the treated solution could be discharged into the sewage waste water system at DNRI.

3.2. Treatment of secondary liquid radioactive waste for volume reduction

According to the initial design procedures, the secondary liquid waste was not treated before cementation. Later, due to the cost of conditioning being rather high (about $4000000VND/m^3$), it was tried to reduce its volume as much as possible. The processing of the treatment is as follows:

(a) Characteristics and Groups of Secondary Liquid waste
Based on the characteristics of the secondary liquid radwaste and its generation, it was divided into three groups A, B, C as shown in Table 1 below:

Table1. Characteristics and Groups of Secondary Liquid Waste

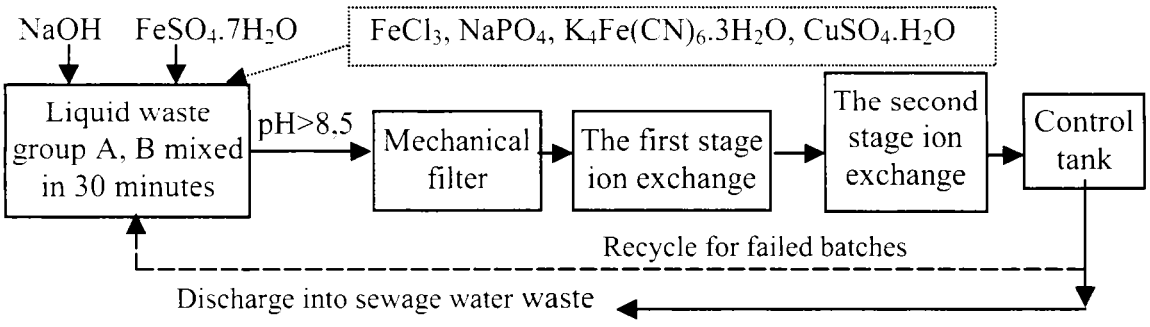
Group	Generation	pH	Conductivity (μS/cm)	Total β activity (Bq/l)	γ activities (Bq/l)			Volume of sludge after one week setting, %
					Co^{60}	Cs^{134}	Mn^{54}	
A	Cleaning Of the filters	6 ÷8	60÷500	370 ÷ 1.270	185 ÷ 450	37 ÷ 370	140 ÷370	10÷20
B	Precipitation Processing	7 ÷9	400 ÷1.000	370÷ 3.700	370 ÷1850	74 ÷ 740	290 ÷590	25÷35
C	Regenerated solution	1÷11	1.000 ÷10.000	450 ÷ 7.000	400÷3.500	440 ÷ 2.100	185÷ 2.960	2÷5

A- Generated from cleaning of the filters, pumps, piles and facility.
B- Generated from chemical precipitation processing
C- Generated from regeneration of the ion-exchanger filters.

(b) Treatment of A and B Group waste by two steps:

The first steps: Separation of the liquid waste into two phases, liquid and sludge. After that, the sludge waste is pumped to interim storage tank and waiting for cementation; the upper solution is pumped to precipitation tank for the 2nd step of treatment.

The second steps: The upper liquid waste is decontaminated by the following processing



In this way, the volume of the secondary liquid waste is reduced to 60% -70%.

3.3. Conditioning of the liquid/sludge radioactive waste

(a) Old and New Facilities and Procedure

Before 1990, solidification of sludge/liquid radwaste was made by the big-old mixing assembly cementation plant [3]. The cementation had to be done directly in the concrete pits, on the laying out solid wastes. After one year, it was shown that, the mixture produced, covered the solid waste was not strong in the pit, the radionuclide could be release into environment. It means we have to change technology and methodology of solidifying liquid/sludge waste at DNRI. It has been done since we have got the new cementation plan, "Be Ba In Drum Mixer" provided by the IAEA under the TC Project VIE/9/007 [3]. From then, the cementation at DNRI became easier and safer.

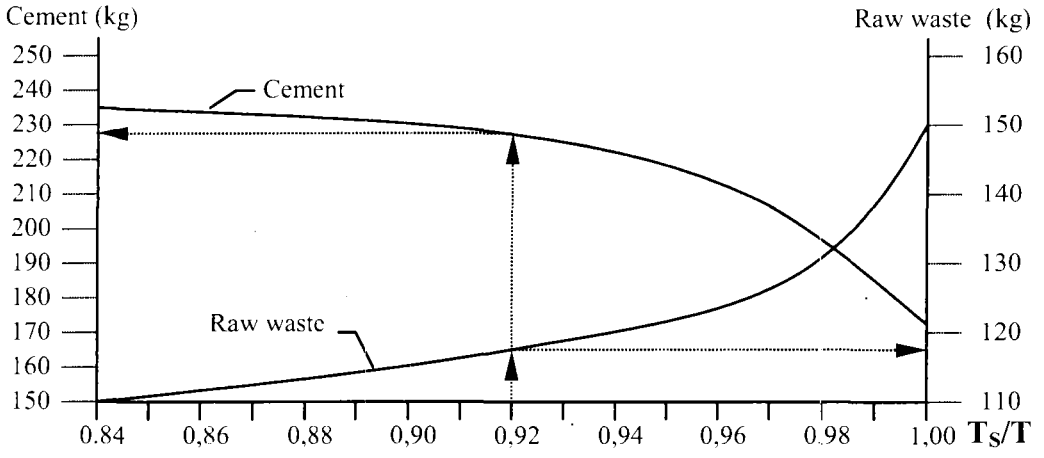
(b) Cementation processing

Preparing (*Waste,* Facility, Drum and Cement)

- Both sludge from storage tank and regeneration solution (C group) are mixed. .
- At present the facility used for the cementation in DNRI is Be Ba Drum Mixer.
- The types of cement used are: Ha Tien and Bim Son P-300 (made in VN).
- Drum for 200 liter, made in Bien Hoa Factory (made in VN).

Experiment and Procedure:
After the prior homogenization of the waste, a sample is taken of the batch to be cemented. The following parameters are important for test in the laboratory:

- pH value, must be in the alkaline range of 8–12 (ideal pH 9).
- Total dry residue T (kg/m^3); the dissolved dry residue Ts (kg/m^3).
- Concentration of chloride, sulfate, phosphate.
- Total β and γ activity, and specific concentration of γ-emitters.
- The amount of liquid/sludge waste and cement per 200-litre drum is determined by using the curves as below.



Example: from the results obtained in experiment case, dissolved dry residue (T_S) is 46 kg/m^3, the total dry residue (T)is 50 kg/m^3, the ratio T_S/T is 0,92. According to the curves shown above, the quantities of waste and cement are:

Quantity of liquid Waste (W)= 118 kg/drum; Quantity of Cement (C) = 226 kg/drum.

This corresponds to a W/C ratio of 0,52.

Mixing Process: the liquid waste is added to the cement in the specified amount and mixed in the drum for 10 minutes.

Test and Assessment: the production drums are controlled after 24 hours. Important factors when assessing the cemented products are: setting of the products without excess water, compressive strength after 28 days. The total activity and surface dose must be controlled (here surface dose less than 50 mR/h).

3.4. Research and development of treatment technique for solid radwaste

According to the design technology and facility for radwaste management, the solid waste at the DNRI did not have to be pre-treated for the storage/disposal. Therefore over the more than first ten years of reactor operation, solid waste was only collected and stored in the storage/disposal facility. At that time, the storage building [4] once or twice a month was opened for receiving solid waste from various laboratories at DNRI. The wastes were placed into one of the eight concrete pits. Day after day, wastes are collected more and more. The question how to treat and condition solid waste becomes very important because a fire could have arisen at any time in the storage building. But this problem was not decided at DNRI before the year 2000 due to lack of the main facilities for these works.

To apply volume reduction treatment technique, the wastes have to be segregated. One segregating box has been constructed by the Waste Management Division and placed in the storage building. Beside that, the DNRI was provided with the " In-drum Compactor" and

some equipment by the IAEA TC Project VIE/9/007. Since then, technology for solid waste treatment has been developed. In order to solve solid wastes generated from beginning up to now, one Country Project has just been implemented successfully at DNRI. More than 60 m3 compactable wastes were compacted in 200litre drums [3], then conditioned in concrete.

Based on laboratory experiments and experience from other countries, the concrete was produced from the following components: Cement: 17 %, Water: 8. %, Sand: 27 %, Gravel: 48 %. After 48 hours of setting, the water in the drum was controlled - it is less than 1%. After 28 days, conditioned drums were finally controlled, labeled and stored in the storage/disposal facility. Now, the management of solid radioactive waste at DNRI is not difficult and a problem faced over a long time could be solved.

4. Conclusion

The IAEA Project VIE/9/007 and experience from other countries in the field of radwaste treatment gradually helped to solve the question not yet settled before. Without, it would have been difficult to manage the radioactive waste at DNRI in the right way. The people who are working in this field have gained much practical experience.
The results of the fellowship/training course and the workshop/seminar materials have provided the necessary topical information and knowledge in the field of radioactive waste management.

It is hoped that in future, with the IAEA and Country support (through Model Project and co-ordinated research) and with the co-operation and encouragement from the FNCA countries, not only waste generated at DNRI will be well managed but that work can be also be applied and developed for other waste producers in Vietnam as well.

References

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