SAFE OPERATION OF EXISTING RADIOACTIVE WASTE MANAGEMENT FACILITIES AT DALAT NUCLEAR RESEARCH INSTITUTE

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Abstract

The Dalat Nuclear Research Reactor was reconstructed from the former TRIGA MARK-II in 1982 and put into operation in March 1984. The combined technology for radioactive waste management was newly designed and put into operation in 1984. The system for radioactive waste management at the Dalat Nuclear Research Institute (DNRI) consists of radioactive liquid waste treatment station and disposal facilities. The treatment methods used for radioactive liquid waste are coagulation and precipitation, mechanical filtering and ion- exchange. Near-surface disposal of radioactive wastes is practiced at DNRI. In the disposal facilities eight concrete pits are constructed for solidification and disposal of low level radioactive waste. Many types of waste generated in DNRI and in some Nuclear Medicine Departments in the South of Vietnam are stored in the disposal facilities. The solidification of sludge has been done by cementation. Hydraulic compactor has done volume reduction of compatible waste. This paper presents fifteen-years of safe operation of radioactive waste management facilities at DNRI.

1. INTRODUCTION

The Dalat Nuclear Research Reactor has been used for research, radioisotope production, neutron activation analysis and training of personnel. It is the main producer of radioactive waste in Vietnam. The whole Institute generates about 100 m^3 - 150 m^3 of liquid waste and 5 m^3 of dry and wet solid radioactive waste per year.

The system for radioactive waste management at the DNRI consists of two main parts:

- the radioactive liquid waste treatment station,
- the disposal facilities

The radioactive liquid waste treatment station collects radioactive waste from the reactor operation, radioisotope production and other laboratories. The treatment methods currently used for liquid wastes are coagulation and precipitation, mechanical filtration and ion - exchange.

Dry and wet solid radioactive wastes are collected and stored in disposal facilities. In this building, eight concrete pits have been constructed for disposal and solidification of radioactive waste. The dry and wet solid waste are treated and conditioned.

2. DESCRIPTION OF THE RADIOACTIVE WASTE MANAGEMENT FACILITIES

2.1 Radioactive liquid treatment station

The radioactive liquid treatment station consists of:

- 4 storage tanks (5 m^3 each) for liquid waste collection and precipitation
- 8 ion-exchange and two mechanical filters
- 16 pumps
- 4 sludge reservoirs
- 4 storage tanks containing alkaline-acid solution.

2.2. The disposal facilities

In the disposal facilities eight concrete pits are constructed for disposal of low level radioactive waste. Each pit is 6 m long, 6 m wide and 3.4 – 5.7 m deep. The thickness of the walls is 0.4 m. The volume of the disposal pits is 896 m^3. An overhead crane, capable of lifting a concrete slab, which covers the pit, does transportation inside the building. The disposal facilities consist of general service, sludge storage tank, waste conditioning and decontamination.

3. WASTE ARISING

3.1 Liquid -sludge radioactive wastes

The main quantity of waste from DNRI is in liquid form. The whole Institute generates about 100 - 150 m^3 liquid wastes per year. The main radionuclides contained in the wastes are I-131, Cr-51, Co-60, Tc-99m, Cs-134, Mn-54, and P-32. The total activity of the liquid wastes is less than 10^{-7} Ci/l [1].

Recently at the DNRI, every year about 5 m^3 of sludge and concentration resulting from liquid waste treatment processes are collected in the interim storage tank located at the radioactive liquid waste treatment station. Then they are pumped to the sludge storage tank located in the disposal facilities. This tank serves as the feeding tank for the cementation process. The main radionuclides contained in the sludge are Co-60 and Cs-134 with total activity less than 2.10^{-6} Ci/l. The density of sludge is more than 10g/l.

3.2 Dry and wet solid waste

Every year about 5 m^3 of dry solid waste from DNRI and some Nuclear Medicine Departments in the South of Vietnam are collected in the disposal facility. Dry and wet solid waste is collected in plastic bags at the working place and then transported to the disposal facilities. According to the IAEA classification for radwastes, most of them belong to low level, short lived wastes.

4. SAFE OPERATION OF RADIOACTIVE WASTE MANAGEMENT FACILITIES

4.1 Treatment methods of liquid wastes

4.1.1 Chemical precipitation

Liquid waste streams in the reactor building are collected in the four storage tanks where the raw waste solution is precipitated by chemicals. Some chemicals and precipitation processes have been tested and used in DNRI. They are hydroxide, phosphate, barium sulfate precipitation and combined processes.

According to the test results in our laboratory, the best precipitation process is hydroxide

$$M^{n+} + nOH^- \Rightarrow M(OH)_n \downarrow$$

Where M^{n+} is Fe^{3+}, Al^{3+} etc.

The solution is treated by adding $FeSO_4$ and NaOH. The pH value of the solution must be more than 8.5. Sometimes we have to use phosphate precipitation for solution including radioactive Strontium. The decontamination factor (DF) is from 50 to 100.

4.1.2 Ion-exchange process

Ion-exchange method has been used to remove soluble radionuclides from liquid waste. After precipitation, the solution is pumped to the ion-exchange units. It is done in two steps, by mechanical filter followed by a two-stage ion-exchange column. The activity of beta and gamma emitting isotopes reaches the level lower than 0.01 nCi/l. The DF is more than 1000. The cleaning solution may be released into the environment or supplied to reactor water preparing system after activity and chemical control.

4.1.3 Conditioning of sludge

Both sludge from the precipitation tanks and the first part regeneration solution (from ion-exchange filters) are collected in 4 tanks of 1 m^3 volume each for interim storage. After that they are pumped to the sludge storage tank located in the disposal facilities.

4.2 Operation of the disposal facilities

4.2.1 The first period - from 1984 to 1992

During this period the main activities in the field of the radioactive waste management are focused on the liquid radioactive waste treatment. Some researches were implemented on the proportion of waste to cement (w/c - ratio) of sludge and volume reduction. The disposal facility twice a month was opened for receiving solid waste from various laboratories in DNRI. The solid waste was thrown into the one of the eight concrete pits. According to the design, the cementation was to be done directly in concrete pits.

4.2.2 The second period - from 1993 up to now

With the help and recommendation from WAMAP Mission, the solidification of waste had been done on an old campaign cementation unit. The cementation was implemented by "In-line mixing cementation process" with a w/c-ratio of 0.47 - 0.50. In this process, the cement was fed with a screw feeder while the waste was fed with mono-pump. From the mixer, the cement waste mixture was directly released into 200 litter drums [2]. The solidified work was very hard and difficult for the following reasons:

- The size of the unit was too big to be used for cementation in 200-litter drums.
- Unable to regulate accurate quantities of the waste and cement, appropriate with the ratio waste / cement.
- There was no possibility to regulate the delivery of products provided by the mixer to the 200-litter drum.

The new in-drum cementation unit-Beba drum mixer has provided by IAEA in the framework of the project VIE / 9 / 007. It was tested and put into operation in April 1996. Thanks for that, the solidified of sludge at DNRI became easier and safer.

We have designed and fabricated equipment to sort the solid wastes, which are collected. The compatible waste is compacted by using hydraulic compactor. This compactor has also provided by IAEA in the framework of the project VIE / 9 / 007. The work related to the solid waste in this period is improved. It is not only collected but also separated; characteristic measured and compacted as well.

5. CONCLUSIONS

Through operation of the facilities we have gained valuable experience in dealing with radioactive waste. Thanks to the implementation of the IAEA Project VIE/9/007 - Infrastructure for Treatment and Management of Radwaste in Vietnam, the radioactive waste management facilities at DNRI are upgraded.

References

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