Radioactive Waste Management In Indonesia

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Abstract
Radioactive Waste Management In Indonesia Since the establishment of the National Atomic Energy Agency in 1958, basic research and development in many areas of science and technology have been carried out for the promotion of atomic energy. Throughout the effort, health and environmental safety have been the primary concern and many studies and works have been directed toward formulating and establishing the national policy with respect to radioactive waste management. This paper presents a board view of waste management policy and programme in supporting the safety aspects of nuclear power programme in Indonesia.

INTRODUCTION
The nuclear programme in Indonesia is dedicated to the peaceful uses of atomic energy to support the national development programme. To reach such objectives, several nuclear research centres have been established. The first research reactor had been put in operation by 1965 which is located at Bandung, West Java, followed by the establishment of research centres in Jakarta and Yogyakarta. To support the need for future nuclear industrial development a new nuclear research establishment in Serpong has been erected and put in operation. The Serpong nuclear establishment consists of several research facilities being organized and operated by several centres, ie. Multipurpose Research Reactor Centre, Nuclear Fuel Element Centre, Radioisotope Production Centre, Materials Science Research Centre, Radioactive Waste Management Technology Centre, Informatics Centre and Reactor Safety Technology Centre.

Throughout all the effort to develop and apply atomic energy, health and safety for worker, population and environment have been the primary consideration as there are stated by the Act No. 31 of 1964 on Basic Provision on Atomic Energy. Based on this Act, all radioactive waste generated from the nuclear programme has to be treated to minimize its effect to population and environment [1]. Therefore, the waste management programmes have been implemented since the beginning of nuclear history in Indonesia, and become an integral part of nuclear energy programme.

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* Nuclear Industrial Development, BATAN
** Radioactive Waste Management, BATAN
POLICY AND OBJECTIVES

The Government Act No. 31 of 1964 states that the development and utilization of atomic energy has to be carried out in such a way as to guarantee the health and safety of workers, population and environment. To carry out the task, the Government has established the National Atomic Energy Agency as a supreme executive as well as control body on the development and utilization of atomic energy.

The structure of the radioactive waste management in Indonesia is illustrated in Figure 1. The structure shows the promotion side as well as the regulation side. On the promotion side, the National Atomic Energy Agency and the Ministry of Science and Technology, set up the plans and coordinate research and development activities. On the regulatory side, the National Atomic Energy Agency, the Ministry of Health and the Ministry of Population and Environment, coordinate the regulation, guidance and criteria as well as examine the safety assessment [2, 3, 4, 5, 6]. The Atomic Energy Control Bureau, beside carrying out the safety examination of the waste management programme also sets up guidance to be implemented by the waste management organization to comply with basic radiation protection requirements as described by ICRP [7] and IAEA Basic Safety Standard [8,9]. The Radioactive Waste Management Technology Centre, under the direction of the Deputy Director General for Nuclear Industrial Development is the undertaking organization as well as responsible for carrying out research and development in radioactive waste management.

The basic policy of waste management in Indonesia is as follows:

- Radioactive waste generation from atomic energy activities should be minimized.
- Any discharge of radioactive liquid and gaseous wastes to the environment should be as low as achievable possible.
- Handling, treatment and disposal of radioactive wastes should be carried out by taking the environmental consideration into account.
- Solid wastes and solidified wastes should be emplaced at nuclear site specially constructed for that purpose.
- Waste management problems are to be taken into account before any larger energy programme is undertaken.
- Research and development in waste management should be carried out to support the safety aspects of future energy programmes.

This policy is implemented in waste management programme as illustrated in Figure 2.
RADIOACTIVE WASTE MANAGEMENT FACILITY

Before the establishment of Serpong Nuclear Facilities, the quantity of radioactive wastes generated from research and application activities was small, consisting of low-level activity and most of the wastes contained short-live radionuclides. The treatment of these wastes was simple i.e. through collection, storage, decay and discharge. The facilities needed were also simple, and can be carried out at each nuclear research facility.

The operation of Serpong Nuclear Facilities generate a larger quantity of low- and medium-level wastes. To deal with these wastes, centralized Radwaste Management Installation (RWI) has been establishment at Serpong. The RWI is operated by the Radioactive Waste Management Technology Centre. This centre is also responsible for coordinating research and development in waste management.

The RWI consists of three buildings; the waste processing building, the engineered interim storage and media-energy supply buildings. The processing building accommodates a facility for waste processing such as evaporator unit of 0.75 m$^3$/h capacity, the hydraulic press of 600 kN for compacting solid wastes, cementation unit to solidify solid, spent resin and concentrate, laundry service units for cleaning and decontamination of personnel protective devices, and storage tanks for liquids and spent resin. An incinerator of 0.5 m$^3$/h capacity is now being installed and will be commissioned by the end of this year. The transport of wastes from waste procedure to the processing building is carried out using a truck trailer. The embedded wastes are stored in the interim storage building which has a 1500 m$^2$ space area. The media and energy supply building provides steam, compressed air, electrical power and auxiliary support system. These building are provided with safety system and auxiliary support to assure safe handlings and processing as well as the effluent control systems.

At present Radioactive Waste Management Technology Centre has 70 personnel, about 30 of them have been trained abroad in several areas of waste management under IAEA or bilateral cooperation.

CURRENT PRACTICE

Waste Generation

At present, the radioactive waste is mostly generated from nuclear research activities from several nuclear research centres located in Bandung, Jakarta, Yogyakarta and Serpong. Small amount of radwaste is also generated from application activities. The total radwaste generated from nuclear research and application in 1990 is presented in Tabel 1.
The radwastes generated from nuclear research activities are mainly low-level wastes. They consist of process wastes, filters and protective devices. Medium-level wastes and high active wastes are only in small quantities.

From nuclear application activities the wastes are mainly spent radiation sources used in nuclear medicine and industry.

Small amount of radioactive waste is also produced from the production of gas mantle lamp and the use of isotopes (Ra-226 and Am-241) in lightning protection devices.

**Waste Treatment Process**

The current practices with respect to radioactive waste management for different categories of wastes and the various schemes which are presently being implemented are briefly presented in Figure 3 and summarized in this section.

**Low and medium-liquid wastes**

The low and medium-level wastes are treated by precipitation or evaporation techniques. In the precipitation methods the pretreatment are carried out to adjust the pH at a proper value, after which, chemicals are added and the sludges are collected and solidified with cement mixture in a 100 l drum. In the evaporation method, evaporation is carried out under atmospheric pressure at slightly alkaline medium. The evaporator unit is a thermo-shipon circulating thermal evaporator with 750 l/h capacity at reduced volume ratio 50 : 1. The evaporator unit is equipped with storage and neutralization tank before process and storage tanks for concentrates (Figure 4).

The sludges are then solidified with cement slurry in a 200 l drum and the concentrates are placed in a concrete shell of 950 l. The spent resin after pretreatment is also solidified with cement slurry in a concrete shell of 350 l. The cementation process is illustrated in Figure 5.

**Low and medium solid wastes**

The solid wastes consist of articles that have been contaminated after being used in radioactive areas or materials resulting from the processes. These wastes are collected in a 100 l drum, and transported to the solidification unit. The compactable wastes in a 100 l drum are the placed
in a 200 ℓ drum and compacted by a 600 kN hydraulic press. The 200 ℓ drum is then moved to the cementation unit for solidification in cement slurry (Figure 6). Spent radiation sources from nuclear application in medicine and industry are solidified either in a 200 ℓ drum or concrete shell of 950 ℓ that can accommodate a higher radioactivity content.

**High Level Activity Waste**

A small amount of high-level waste is generated from Mo-99 production. This waste contains fission products of U-235. At present these wastes are collected in a borosilicate glass and stored in a high-integrity stainless steel tank. It is necessary to solidify these wastes into stable and inert form for long term period.

**Storage of the Solidified Wastes**

The solidified wastes are stored in the interim storage building. This building is constructed of cement and bricks with wall thickness of 40 cm to provide the radiation shielding. It is divided in two areas for storage of drums and concrete shells. The drum storage area is of 500 m² which accommodates 1500 drums of embedded wastes, while the shell storage area is of 1000 m² which accommodates 500 concrete shells. This facility is designed in such a way to allow or anticipate expansion of additional storage area, by addition of modules which can be placed side by side.

**Spent Fuel**

The Spent fuel is not processed. It is still kept in the reactor bay. At present there are 25 spent fuels accumulated in the research reactor in Yogyakarta, 75 in the Bandung reactor and 9 in the new reactor in Serpong. In the future about 50 spent fuels will be accumulated annually from the Serpong Research Reactor Centre. According to the waste management programme, these spent fuels will be stored in a retrievable interim storage facility. The design and safety assessment of the interim storage is now being undertaken and it is expected that the construction of the facility will be commenced in early 1994.
FUTURE PROGRAMME

One of our future programmes on waste treatment is dealt with high-level and alpha-bearing wastes being generated in a small quantity from the isotope production and the radiometallurgy laboratories. Several experiments have been carried out to handle these wastes in glass matrices. A study for the development of improved matrices for incorporation of these wastes, is being carried out, particularly in conjunction with long-term stability of the solidified product. Another work to be taken is the study of the centralized shallow land repository and retrievable interim spent fuel storage at Serpong. Another aspect of work to be carried out in the future will be the development of techno-economically viable waste management process. The effort towards the demonstration is required, completed with field experimental data, to establish an adequate public confidence on the safety aspect of waste management. This work is planned to obtain greater public support to the near future nuclear power programme.

To provide the specialist needed for further development of waste management, it is also necessary to conduct trainings of engineers, chemists, health physicists and technicians. Trainings through bilateral and international cooperation are expected. In this case, the role of IAEA is very important in providing experts and trainings in different areas of waste management.

SUMMARY

In terms of the magnitude of problems and the efforts already taken, the radioactive waste management is adequate for the present nuclear activities in Indonesia. The present experience in managing the low- and medium-level wastes has been assumed adequate also. It is expected that in the near future our waste management programme can be effective in handling high-level and alpha-bearing wastes. This will be a step forward to meet our objectives in supporting greater nuclear programme, especially in the field nuclear power.

REFERENCES

1. Act of the Republic of Indonesia No. 31/1964 on Basic Provision on the Atomic Energy
4. Government Regulation of the Republic of Indonesia No. 12/1975 on the Licencing of the Use of Radioactive Materials and/other Radiation Sources
5. Government Regulation of the Republic of Indonesia No. 13/1975 on the Transport of Radioactive Materials

Table 1. Radwaste generated from nuclear research and application activities

<table>
<thead>
<tr>
<th>Nuclear Research</th>
<th>Application</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid ($10^{-6} - 10^{-3} \text{Ci/m}^3$)</td>
<td>Liquid ($10^{-6} - 10^{-4} \text{Ci/m}^3$)</td>
<td>Spent sources :</td>
</tr>
<tr>
<td>Solid (up to 1 R/h)</td>
<td>Spent sources :</td>
<td>Radiography, logging and gauging</td>
</tr>
<tr>
<td>Spent resin</td>
<td>(Ir-192, Cs-137, Co-60, Ra-226)</td>
<td>(Co-60, Cs-137, Ir-192, Am-Be, etc)</td>
</tr>
<tr>
<td>2000 m$^3$</td>
<td>4 m$^3$</td>
<td>126 units</td>
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<tr>
<td>3500 kg</td>
<td></td>
<td>200 units</td>
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<tr>
<td>360 kg</td>
<td></td>
<td>20 drums</td>
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<td>(200 l)</td>
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Figure 1. Radwaste Management Structure
Figure 2. Radwaste Management Programme
Figure 3. Radwaste Treatment Process

Figure 4. Evaporation of Liquid Waste
Figure 5. Solidification of Concentrate and Resin

Figure 6. Treatment of Solid Waste