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MANAGEMENT OF SPENT SEALED SOURCES IN INDONESIA

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Abstract.

This paper describes the effort of the Center for Development of Radioactive Waste Management (CDRWM) to develop and implement activities in maintaining and improving the safety of spent sealed radiation sources and the security of radioactive materials over their life cycle. There is a wide variety of uses of radiation sources and radioactive materials in Indonesia, while the CDRWM plan to cover all spent radiation sources. Primary consideration is given to sealed radiation sources with relatively high levels of radioactivity which might necessitate interventional measures should control over them be lost. The policy of the Government of Indonesia for spent radiation sources is, whenever possible, spent sealed sources should be returned to the supplier. CDRWM has a general principle that sealed sources should not be removed from their holders, or the holders physically modified (except for Ra-226 needles, smoke detector and lighting preventer).

1. Introduction

Radiation sources, utilizing either radioactive materials or radiation generators, are used in Indonesia for a wide variety of peaceful purposes, in industry, medicine, research and education. Many uses involve sealed sources with the radioactive materials firmly contained or bound within a suitable capsule or housing; some, also, involve radioactive materials in an unsealed form. The risks posed by these sources and materials vary widely, depending on the radionuclides, the forms, the activities, etc. Unless breached or leaking, sealed sources present a risk from external radiation exposure only. However, breached or leaking sealed sources, as well as unsealed radioactive materials, may lead to contamination of the environment and the intake of radioactive materials into the human body.

Radionuclides produced artificially in nuclear facilities and accelerators have become widely available, not only radium-226, but also cobalt-60, strontium-90, caesium-137 and iridium-192. The risks associated with the use of radioactive materials must be restricted and protected against by the application of appropriate radiation safety standards. The risks associated with the planned use of radiation sources and radioactive materials are generally well known and the relevant radiation safety requirements generally well established. Nevertheless, accidents can occur during use[1].

Sealed sources or their containers can have a certain attractiveness because of their appearance or their apparent value as scrap metal. The subsequent handling of such sources and containers by workers and members of the public unaware of the inherent hazards can give rise to external irradiation or, if tampered with, the possibility of internal exposure. This has led to serious injury and in some cases death. Sources incorporated into scrap metal for subsequent recycling can lead to the contamination of plant and the environment, possibly

with serious economic consequences[2]. Fig.1 is a graph that describe the prediction of the future spent radiation sources conditioned in Center for Radioactive Waste Management Development (CDRWM) Serpong [3]. The prediction is based on the experiences of CDRWM, report from Nuclear Energy Regulatory Board (NERB), and information from the Ministry of Public Health.

2. Objectives

The primary purpose of this paper is to describe the effort of CDRWM to develop and implement activities in maintaining and, improving the safety of radiation sources and the security of radioactive materials over their life cycle. As noted in the introduction, there is a wide variety of uses of radiation sources and radioactive materials in Indonesia. The activity plan of CDRWM covers all spent radiation sources. Primary consideration is given to sealed radiation sources with relatively high levels of radioactivity which might necessitate interventional measures should control over them be lost.

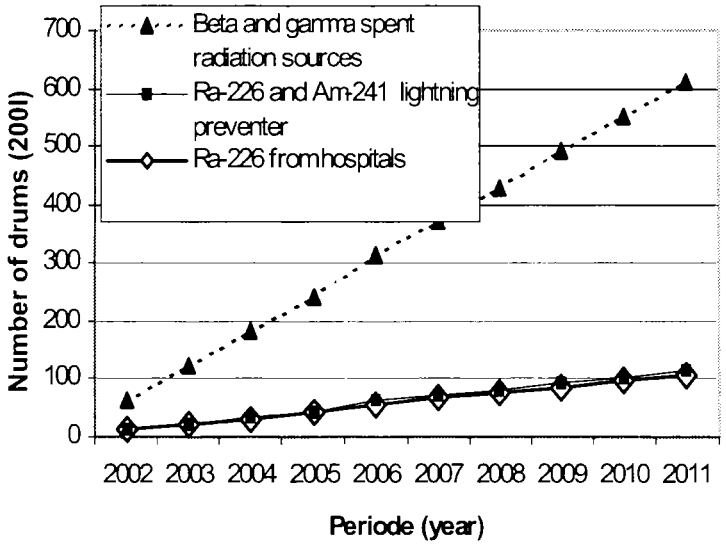


Fig.1 Prediction of cummulative spent radiation sources conditioned in CRWMD

3. Principles of management of spent radiation sources in Indonesia

(a) Sources of ionizing radiation must have sufficient protection to allow for safe normal operations.

(b) The possibility of accidental exposures involving radiation sources must be anticipated and there must be appropriate safety devices and procedures. In this connection Indonesia and especially CDRWM has actions such as:
   (i) weaknesses in the design and construction of radiation sources must be corrected;
   (ii) a high level of safety culture in the handling of radiation sources must be promoted, so that human errors are minimized through good training.

(c) The regulatory infrastructures for the control of radiation sources is supported by the Government of Indonesia and be able to act independently, and the Nuclear Energy Regulatory Board (NERB) maintain oversight of all radiation sources in Indonesia.

(d) Radiation sources should not be allowed to drop out of the regulatory control system. This means that the NERB must keep up-to-date records of the person responsible for each source, monitor transfers of sources and track the fate of each source at the end of its useful life.

The Government of Indonesia has established NERB. The Government of Indonesia provides the NERB with sufficient backing and with sufficient human and financial resources to enable it to function effectively

4. Management of spent sealed sources

The policy of the Government of Indonesia for spent radiation sources is that whenever possible spent sealed sources should be returned to the supplier. CDRWM has a general principle that sealed sources should not be removed from their holders, or the holders physically modified (except for Ra-226 needles, smoke detector and lighting preventer).

CDRWM is developing the management information system (MIS) for the database of all waste stored in CDRWM. This system is used to identify accurately and immediately on the transportation and storage of the radioactive waste. The other objective of MIS is to control the record of the waste history (transportation, treatment/conditioning, and storage).

Present development of detailed records for all spent sealed sources in storage includes:
Identity code (if known), radionuclides present, original activity/date, physical and chemical form, source dimensions, geometry, details of shielding (e.g. gross weight - including shielding containers), results and date of a previous leak test, measured dose rate and details of measurement equipment used (type, -model, serial number), supplier of the source, owner, last user of the source (details and persons responsible).

The regulatory body is informed when a sealed source is taken out of use, and becomes a spent source in storage.

Spent sealed sources are segregated and collected separately because of their potentially high radiological hazard. Spent sealed sources generally are not removed from their associated shielding or source holders unless adequate precautions are taken to avoid exposure to radiation and contamination. Peripheral components of large irradiation equipment (i.e. those not directly associated with the source) are removed, monitored and disposed of appropriately. Sealed sources are not subjected to compaction, shredding or incineration.Special conditioning techniques are required for spent radium sources. Spent radium sources are stored in an appropriate interim storage area with strict access control and radiation monitoring.

CDRWM has a strategy to handle the radium by applying simple but effective methods of increasing the security of spent sealed sources. A potentially suitable method of securing spent sources is to contain the spent sources or source holders in a suitable size concrete metal drum (200 L). A convenient way to embed the source in concrete would be to place it in the center of the 200 l drum that is filled with concrete. When immobilizing spent sealed sources the need for security and possible long-term retrievability of the drum is always considered.

4.1 Quality Assurance

A comprehensive quality assurance program has been established in CDRWM and periodically inspected by regulatory body (NERB). This program is in progress, and integrated in the administration of radioactive waste management. Particularly for management of spent radiation sources includes the following items: quality of the capsule material and the-capsule welding process; quality of the operational procedures (Handling, segregation, characterization, treatment and conditioning, packaging, storage and disposal of radioactive waste at the centralized radioactive waste management facility, and transportation); quality of the calibration of all monitors and radioactivity measurement; quality of the documentation of information and their retrieval.

Quality assurance programmes aim to ensure confidence that all operations are optimally managed, waste disposals and discharges are within authorized limits, and conditioned waste packages are produced in accordance with the specifications for storage, transportation and for possible disposal[4].

A quality assurance programme is developed as part of the license application by CDRWM and reviewed and approved by the regulatory body. The programme defines and describes the organization, responsibilities relevant quality assurance steps and organizational interfaces involved in predisposal waste management. A system for document control and records provide evidence that the required quality has been achieved. One of the references of the quality assurance programme is IAEA safety series No. 50-C/SG-Q[4].

4.2 Technical requirement for conditioning of spent sealed sources

The main aspects covered in this section are manpower requirements and their qualifications, operational requirements including materials/consumables, equipment and tools for conditioning of spent radiation sources [5].

4.2.1. Personnel qualification

The team in CDRWM conducting the operation have large experience and proper qualification to undertake this work. The *team leader* is the head for solid waste treatment sub division, and is a first university degree in Engineering, Physics or a related field. He has enough experience in the field of waste conditioning and a related R&D area. This team leader has headed similar operations. The *health physicists* have a first university degree in Nuclear Physics, Engineering or a related area. They all have enough experience in radiation protection and have participated in some major operations involving work in radiation areas, major decontamination or conditioning. The *welder* is qualified for the TIG welding process by IAEA (for Ra-226 conditioning).

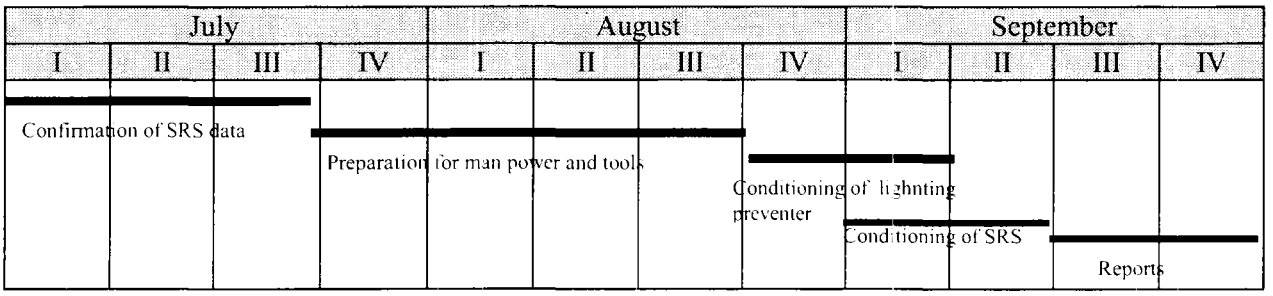
4.2.2. Facilities

The operation requires a storage facility and a laboratory area (operational area) adjacent to the storage facility or nearby for convenience. CDRWM has a laboratory for Ra-226 conditioning, and also to dismantle lightning rods. This laboratory is just 100 m from the interim storage where the conditioned spent radiation sources are placed. All facilities are almost available, except some tools for Ra conditioning, partly supported by the IAEA.

4.2.3. Work plan

An *action plan* is initially developed. It identifies all actions to be carried out from the time of the approval of the conditioning operation to the end of the conditioning of the sources. Below is the work plan of the recent action by CDRWM on the conditioning of spent sealed sources.

Table 1. Schedule for conditioning spent radiation sources, July-September 2001



4.2.4. Preliminary work

CDRWM has all information regarding the sources inventory and specifically the total activity, the number of individual sources, their geometry and the hermeticity of the sources (this will be developed and integrated in our management information system of radwaste data). The shielding device is designed using, a suitable dose assessment to optimize the shielding container from weight, radioactivity capacity, volume and external dose rate points of view. The shielding container is prepared prior to. Stainless steel capsules for the encapsulation of the radium sources need to be manufactured. The capsule size needs to take into consideration the source size and shielding device geometry. In March 2001, CDRWM has conditioned all Ra-226 (needles and lightning preventers) stored in CDRWM supported by the IAEA. But CDRWM is still in progress for the agreement with the Public Health Department for the conditioning of Ra-226. At the end of this stage, all sources are stored in interim storage.

Table 2. Total data of Ra-226 in Indonesia [2],[3],[6]

No.	Type	Stored in CDRWM	Stored in Hospital, etc.	Total (Ci)*)
1.	Needle	17	576	3 Ci
2.	Lightning preventer	320	320	0.4 Ci

*) Approximately

4.2.5. Conditioning phase

Proper procedures are adopted for source transfer from the temporary storage to the conditioning area. The ALARA principle is well observed with regard to the exposure rate of the operating staff. Drum preparation is carried out according to technical procedures and prior to the conditioning operation in order to have the drums ready for final use. CDRWM use the concrete drum 200l for lightning rod and Ra conditioning, and use the concrete shell 950 to emplace the other spent sealed sources. These are the simplest way to ensure the integrity and security of the sources. During the entire operation, no work involving radioactive materials is conducted which has not been forecasted, planned and for which tested procedures have been developed. Continuous and systematic monitoring and control of contamination must be carried out [7].

5. Recent work

Results of the recent activities on conditioning of spent radiation sources are shown below.

Table 3. Results of SRS conditioning (August 27 – Sepetember 12, 2001)

No.	Concrete drum 200l/ Concrete shell 950l	Exposure dose (μSv/jam)		Remarks
		Contact	1m	
1	Concrete drum No. 97	3.56	2.4	4 boxes Pb of U depleted
2	Concrete drum No. 98	61.2	15.8	2 units Am-241, 6 units Sr-90, 1 unit Ir-226, 1 unit Ra-226, 5 units of Pu-239
3	Concrete drum No. 99	37.5	6.7	23 units Co-60
4	Concrete drum No. 102	3.3	2.4	4 units Pm-147, 8 units Kr-85, 7 units Sr-90, 1 unit Fe-55
5	Concrete drum No. 104	29.3	8.2	59 capsuls Ra-226, 1 unit Ra-226
6	Concrete drum No. 125	676	80.8	84 units Ra-226 from lightning preventer
7	Concrete drum No. 126	1.07	0.86	100 units Am-241 from smoke detector 57 unit Am-241 from lightning preventer
8	Concrete shell 950L	347	24.4	8 units Co-60, 47 units Cs-137, 1 box Co-60

It is scheduled that by the end of 2002, CDRWM will have treated all radium spent sources that are still stored at the Ministry of Public Health of Indonesia and in some hospitals.

References

[1] IAEA, Management of small quantities of radioactive waste, IAEA-TECDOC-1041, Vienna, 1998.

[2] NERB, Report on Nuclear Safety in Indonesia, NERB, Jakarta, 2000.

[3] CDRWM, Internal Report on Spent Sealed Radiation Sources, CDRWM, Serpong, 2001.

[4] IAEA, Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installation, Safety Series No. 50-C/SG-Q, Vienna, 1996.

[5] IAEA, Regional Training Course on Management of Spent Radiation Sources and other waste from small nuclear application, PNRI, Manila, 1995..

[6] CDRWM, Summary Report of Ra-226 Conditioning, CDRWM, March, 2001.

[7] CDRWM, Quality assurance program in Indonesia, Revision 6, CDRWM, November 2001.