MANAGEMENT OF SPENT RADIATION SOURCES IN INDONESIA

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ABSTRACT

Management Of Spent Radiation Sources In Indonesia

In Indonesia the spent radiation sources are generated mainly from medical/hospital, industrial, and research applications. From medical application the spent sources consist of Co-60 and Cs-137 for teletheraphy, and Ra-226 for brachytherapy. In industrial application the spent sources are consisting of Co-60 and Cs-137 for radiography, Ra-226 and Am-241 for lightning protection devices, ^{241}Am-Be, Cs-137, Co-60, Ra-226, and Cf-252 for logging, Kr-85, Sr-90, Co-60, and Cs-137 for gauging, and Co-60 for sterilization and food preservation. The spent sources that comes from research application are only Co-60 for irradiator. The spent radiation sources must be managed safely to avoid the risk of radiation hazards to workers and public as well as protection of the environment. Various of spent radiation sources in Indonesia including accumulation amounts, its treatment, conditioning, and management are described. The Radioactive Waste Management Development Center of national Nuclear Energy Agency (BATAN) is the undertaking organization to be responsible for carrying out the spent radiation sources management as the Executing Body.

INTRODUCTION

The use of nuclear energy in Indonesia to support the national development programme shall give due consideration to the safety, security, peace, health of workers and public, protection of the environment, as well as the utmost use for public prosperity. It is stated by the Act Number 10 Year 1997 on Nuclear Energy replacing the Act Number 31 Year 1964 on Basic Stipulation of Atomic Energy [1]. The meaning of use of nuclear energy is quite extensive, since it includes the research, development, mining, manufacturing, production, transportation, storage, transfer, export, import, usage, decommissioning, and radioactive waste management. Considering that the use of nuclear energy can enhance public welfare in many fields, the public, the private industry, or the government shall be given as much opportunity as possible to the use of nuclear energy under the existing regulation.

The use of nuclear energy shall be controlled thoroughly in order to comply with the regulation in nuclear safety, so that the use of nuclear energy will not cause radiation hazards to worker, the public, and to the environment.

Since the beginning of the nuclear activities in Indonesia, the National Nuclear Energy Agency of Indonesia (BATAN) formerly known as the National Atomic Energy Agency has implemented the Radioactive Waste Management Program with the following objectives [2]:

(a) To assure that no one shall receive any radiation doses, that comes from radioactive wastes, exceeding the limit of permissible value according to recommendations of the International Commission on Radiological Protection (ICRP), and
(b) To master the practical and safe technologies for radioactive waste management

The Radioactive Waste Management Technology Center (RWMTC) of BATAN is the undertaking organization to be responsible for carrying out the radioactive waste management as the Executing Body. The RWMTC is responsible for handling, treating and storing of radioactive waste arising from the nuclear research and application activities, as well as monitoring the environment and radiation worker safety of the Serpong Nuclear Complex, and carrying out R&D in various fields of radioactive waste management to meet the present and future needs.

The user generating low level and intermediate level radioactive waste shall be obligated to collect, segregate, or treat the Executing Body. That's obligation is including to manage the radioactive waste within the location of the nuclear installation so that they will not pose hazards to workers, the public and to the

environment, and enabling further easy management by the Executing Body. The purpose of temporary disposal is to reduce the radiation level of short half-life radioactive materials before transferring them to the Executing Body [1].

The radioactive waste management shall be administrated by the Executing Body based on the safety concern and technical capability possessed by the Executing Body and also for the easiness in implementation of control. The managements are administrated in a non-commercial manner [1].

Today sealed radiation sources are used in medicine, research, and industrial applications, in mobile as well as stationary devices. The spent radiation sources from producer are transported to the RWMTC by waste transporter (truck type), and stored in the interim storage for pretreatment. After characterization, the spent radiation sources are conditioned and stored in the interim storage for high active waste. A part of the spent radiation sources are immobilized with cement matrix in the concrete shell and then stored in the interim storage before sendin g to the final storage. To present the management of spent radiation sources in Indonesia, it will be described the spent radiation sources generating from nuclear application in Indonesia including accumulation amounts, its treatment, conditioning, and ma nagement.

SOURCE OF SPENT RADIATION SOURCES IN INDONESIA

In Indonesia the spent radiation are generated mainly from medical/hospital, industrial, and research applications.

Spent Radiation Sources from Medical Applications

Hospitals are still among the largest users of sealed radiation sources. They are mostly used for teletheraphy and brachytherapy. The radionuclide used in teletheraphy sources is Co-60, but some Cs-137 sources are also in service. Because of the large activity of these sources, 0.1 – 0.5 PBq (one petabecquerel equals 10^{15} becquerels), they are always used in heavily shielded " radiation heads" which weigh of the order of one tonne. Since these are usually not designed or approved for use in transport there can be problems when obsolete or unusable units, still containing the radiation source, have to be moved. The fact that the shielding material in the radiation head can have high scrap value adds to the risk[3].

Today most of the old radium sources previously used for brachytherapy have been replaced by sources containing Co-60, Cs-137, Ir-192 or other radionuclides. Because the replacement of radium can be expensive, and because some radiotherapists have not yet learned the new techniques, radium sources are still in use in some hospitals.

The spent radiation sources from medical applications in Indonesia are shown in Table I.

Table I. List of Spent Radiation Sources Generating by Medical Application Activities

No.	Type of Spent Radiation Sources	Activity/Surface Contact Dose Rate	Quantity	Producer of Spent Radiation Sources	Receiving Date
1.	Uranium depleted	0.3 mRem/hour	1 piece in drum container 100 L	Central Hospital of Pertamina, Jakarta	26-10-1994
2.	Ra-226	120 mCi	12 pot Ra in drum container 100 L	Hospital of Cipto Mangunkusumo, Jakarta	15-01-1991
	Cs-137	647.13 Ci	1 container of Pb		
	Co-60	484.85 Ci	1 container of Pb		
3.	Ra-226	153 mRem/hour	1 container of Pb	Hospital of Baptis Kediri	03-11-1995
4.	Cs-137	2,000 Ci	1 container of Pb	Hospital of Dr. Kariadi, Semarang	28-12-1995
5.	Cs-137	1,200 Ci	2 containers of Pb	Hospital of Dr. Sutomo, Surabaya	15-01-1996
	Co-60	4,000 Ci			

6.	Co-60	1,300 Ci	1 container of Pb	Hospital of Cikini, Jakarta	23-04-1997
7.	Co-60	1,000 Ci	1 container of Pb	Hospital of Persahabatan, Jakarta	16-04-1998

Spent Radiation Sources from Industrial Applications

The industrial sources giving most cause for concern are those used for industrial radiography. Worldwide Ir-192 is the most common radionuclide in this context, but Co-60 and Cs-137 are also used. The activity ranges from 0.1 up to many TBq [3].

Large neutron and gamma sources are used for well-logging in the oil and mining industries. These are similar to the sources used for moisture and density measurements but are of higher activity. Although the number of these sources is small in comparison with the number used for NDT, they represent the same type of high risk sources due to how and where they are used, The radionuclides of ^{241}Am-Be, Cs-137, Co-60, Ra-226, and Cf-252 are used for logging.

The most widely used industrial sources are in level and thickness gauges, which are usually used in fixed installation. The radionuclides of Ra-226 and Am-241 are used for lightning protection devices, and Co-60 for sterilization and food preservation.

The spent radiation sources from industrial application in Indonesia are shown in Table II.

Table II. List of Spent Radiation Sources Generating by Industrial Application Activities

No.	Type of Spent Radiation Sources	Activity/Surface Contact Dose Rate	Quantity	Producer of Spent Radiation Sources	Receiving Date
1.	Cs-137	3.5 mRem/hour	12 containers of Pb	PT. Freeport Indonesia (Mining Company)	09-03-1993
2.	Sr-90	18 mCi	3 pieces	PT. Gudang Garam (Cigarette Company)	01-03-1993
		25 mCi	7 pieces		
		25 mCi	12 pieces		
3.	Co-60	1.46 mRem/hour	2 pieces	Pertamina Dumai (Oil Company)	20-03-1993
	Cs-137	1.22 mRem/hour	16 pieces		
4.	Kr-85	137 mCi	6 pieces	PT. Indah Kiat (Paper Company)	27-03-1994
		500 mCi	3 pieces		27-02-1999
		250 mCi	1 piece		
	Cs-137	250 mCi	1 piece		
		50 mCi	1 piece		
		10 mCi	6 pieces		
	Co-60	72.63 mCi	1 piece		
5.	Co-60	19.3 mRem/hour	2 pieces in 1 container of Pb	PT. Yasinta Poly (Textile Company)	06-06-1994
6.	Co-60	0.5 mRem/hour	1 piece of container	PT. Total Indonesia (Oil Company)	20-01-1994
7.	Uranium depleted	2.6 mRem/hour	2 pieces of uranium depleted in 1 container	PT. Garuda Indonesia (Airways Company)	03-11-1994
8.	Cs-137	150 mCi	1 piece	PT. Hanil Jaya Metal Works	31-10-1994
9.	Lightning protection devices of Ra-226 and Am-241	-	230 pieces	PT. Multi Sigma Cakrawala	09-12-1991

No.	Type of Spent Radiation Sources	Activity/Surface Contact Dose Rate	Quantity	Producer of Spent Radiation Sources	Receiving Date
10.	Kr-85	40.10 µSv/hour	2 pieces in container of Pb	PT. Ciwi Kimia (Paper Company)	23-03-1995

	Pm-147	1.48 mSv/hour	2 pieces in container of Pb		
11.	Co-60	0.025 µSv/hour	6 pieces		29-03-1995
	Cs-137	1,500 mCi	1 piece	PT. Rukindo (Harbor	29-05-1995
	Co-60	90.94 and 96 mCi	5 pieces	Dredging Company)	01-06-1995
		158 and 166 mCi	4 pieces		01-06-1995
12.	Co-60	107.43 and 180 mCi	3 pieces	PT. Pupuk Kaltim (Fertilizer Company)	11-04-1995
13.	Ir-192	$2.93.10^{-23}$ Ci	1 piece		
		$3.36.10^{-21}$ Ci	1 piece		
		$2.10.10^{-21}$ Ci	1 piece		
	Cs-137	25 mCi	4 pieces	Pertamina Plaju	03-05-1995
	Co-60	5 Ci	1 piece	(Oil Company)	
	Ir-192	20.10^{-4} Ci	4 pieces		
		2.10^{-20} Ci	4 pieces		
		10.10^{-12} Ci	4 pieces		
14.	Pm-147	0.2 mRem/hour	1 piece in container of Pb	PT. Bukit Muria Jaya (Paper Company)	27-10-1995
15.	Am-241	250 mCi	1 piece in container of Pb	PT. Parindo Permai (Paper Company)	10-11-1995
16.	Cs-137	100 mCi	2 pieces in container of Pb	Pertamina Cilacap (Oil Company)	06-11-1995
17.	Ir-192	0.1 mRem/hour	18 pieces in container of Pb	PT. Sucofindo (Surveyor Company)	02-01-1996
18.	Cs-137	100 mCi	5 pieces in container of Pb	PT. South Pacific Viscose (Synthetic Fibre Company))	24-02-1997
		200 mCi	1 piece		27-02-1999
		2,000 mCi	1 piece		
		1,000 mCi	3 pieces		
19.	Cs-137	200 mCi	2 pieces in container of Pb	Pertamina Rewulu (Oil Company)	14-07-1997
20.	Am-Be	16 Ci	7 pieces	PT. Schumberger (Oil Company)	14-10-1997
		0.5 Ci	12 pieces		
	Cs-137	1.5 Ci	11 pieces		
	Co-60	0.0004 Ci	6 pieces		
21.	Co-60	100 mCi	2 pieces	PT. Semen Padang (Cement Company)	02-12-1998
22.	Cs-137	28 mSv, 15 mSv and 45 mSv	3 pieces	PAIR (Diverse Company)	06-01-1998
23.	Kr-85	250 mCi	1 piece	PT. Kertas Bekasi Teguh (Paper Company)	14-05-1998
24.	Ra-226 and Co-60	2 mRem/hour	52 container of Pb	PAIR (Diverse Company)	12-09-1990 until 15-07-1993
25.	AmBe	100 mCi	2 pieces	PT. Arutmina Indonesia (Mining Company)	19-09-1998
26.	Cf-252	86.8 mCi	2 pieces	PT. Semen Cibinong (Cement Company)	14-01-1999
27.	Ir-192	1 mCi	4 pieces	PT. Inkoray (NDT Company)	23-03-1998

Spent Radiation Sources from Research Application

The spent radiation sources that comes from research application are Co-60 for irradiator, until now it is still in use in the Research Center for Isotopes and Radiation Applications. On the other application, the radionuclides of H-3, P-32 and H-3 are used on the health research.

The spent radiation sources from research application in Indonesia are shown in Table III.

Table III. List of Spent Radiation Sources Generating by Research Application Activities

No.	Type of Spent Radiation Sources	Activity/Surface Contact Dose Rate	Quantity	Producer of Spent Radiation Sources	Receiving Date
1.	H-3, P-32, C-14	250 µCi	14 pieces in container of Pb	Eijkman Research Center	24-02-1997
2.	H-3, P-32, C-14	250 µCi	12 pieces in drum 100 L	Infect Desease Research Center	06-05-1997

SPENT RADIATION SOURCE MANAGEMENT IN INDONESIA

The objective of spent radiation source management is to assure that no one shall receive any radiation doses, that comes from spent radiation sources, exceeding the limit of permissible value. The scopes of management by the user generating spent radiation sources are collection, segregation, or treatment and temporally storage those sources being transferred to the Radioactive Waste Management Facility, RWMTC. The RWMTC has several facilities for the treatment of various types of radioactive waste including spent radiation sources. The radioactive waste treatment process existing in the RWMTC are shown in Figure 1 [4].

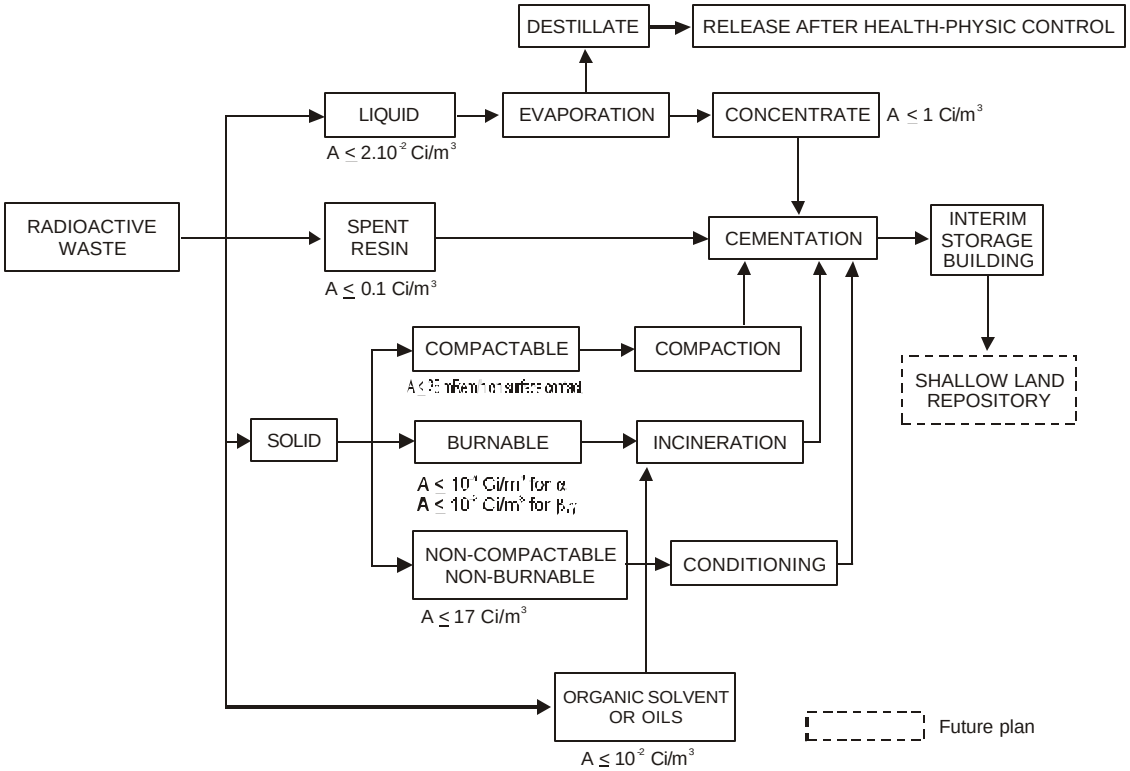

Fig. 1. Radioactive Waste Treatment Process Existing in the RWMTC

After verification and control by the Regulatory Body and the Executing Body, the spent radiation sources from producer are transported to the RWMTC by wastes transporter, and than stored in the storage before treatment for preparation of pretreatment. The activities of pretreatment preparation are including the spent radiation sources characterization covering identification of radionuclide, measurement of dose rate at surface contact and 1 m from surface, measurements of total activity, dimension and weight, sorting and dismantling. From pretreatment operation it is identified the short life spent sources that will be immobilized in

the concrete shell with cement matrix or the long life of spent sources that will be conditioned in the stainless steel box or stainless steel drum depending on the dimension.

After treatment process of spent radiation source conforming its characterization, it is necessary to put labeling and numbering of the embedded waste from treatment process operation. The embedded wastes are than transfer to interim storage.

Flow diagram of the management of spent radiation source is shown in Figure 2.

CONCLUSION

The spent radiation sources in Indonesia are generated mainly from hospital, industrial, and research applications. From medical application the spent sources consist of Co-60 and Cs-137 for teletheraphy, and Ra-226 for brachytherapy. In industrial application the spent sources are consisting of Co-60 and Cs-137 for radiography, Ra-226 and Am-241 for lightning protection devices, ^{241}Am-Be, Cs-137, Co-60, Ra-226, and Cf-252 for logging, Kr-85, Sr-90, Co-60, and Cs-137 for gauging, and Co-60 for sterilization and food preservation. The spent sources that comes from research application are only Co-60 for irradiator. The spent radiation sources must be managed safely to avoid the risk of radiation hazards to workers and public as well as protection of the environment. The Radioactive Waste Management Development Center of national Nuclear Energy Agency (BATAN) is the undertaking organization to be responsible for carrying out the spent radiation sources management as the Executing Body.

The management of spent radiation sources consists of the activities of collection, identification, transportation, interim storage before treatment, pretreatment, treatment process, and interim storage. From pretreatment operation the spent radiation sources are identified on the short life spent source that will be immobilized in the concrete shell with cement matrix, and the long life spent source that will be conditioned in the stainless steel box or stainless steel drum. After treatment process it is necessary to put identification, labeling and numbering on the embedded waste before transferring to the Interim Storage.

REFERENCE

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2. National Atomic Energy Agency Annual Report 1996/1997

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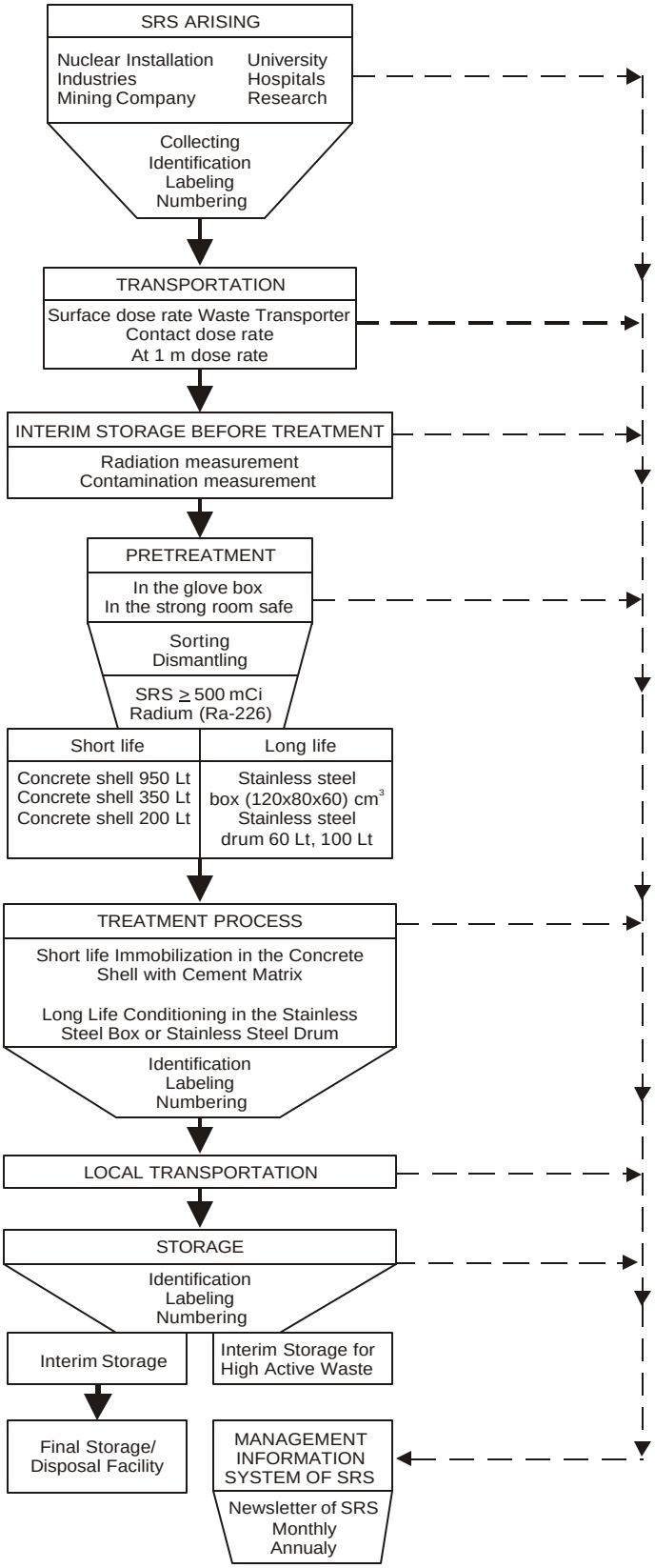

Fig. 2. Flow Diagram of the Management of Spent Radiation Source in Indonesia