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MANAGEMENT OF RADIUM NEEDLES USED FOR MEDICAL AND INDUSTRIAL APPLICATIONS IN ALBANIA

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Abstract

The use of radium and other radiation sources in Albania in the area of medicine and industry is outlined. The efforts and current activities undertaken by the Institute of Nuclear Physics to safely manage disused radiation sources in Albania are described.

1. Introduction

The use of Radium (^{226}Ra) experienced rapid growth until 1950. Until the end of 1975, Albania imported some Radium sources from Russia and China. The Radium was of major scientific interest and was used in Albania in a growing number of applications. In medicine, at the University Hospital Center (UHC), Radium was used in the form of needles and tubes for brachytherapy. In research, at the Institute of Nuclear Physics (INP), Radium was used for calibration of dosimetry equipment. In industry, at the Geophysical-Geochemical Enterprises (GGE), Radium was used for humidity control by neutron sources. Now, the use of Radium sources has been discontinued in Albania. In accordance with recommendations of the IAEA for conditioning of spent Radium sources and the IAEA transport regulations, various activities are realized at INP with respect to the safe management of radium sources. The proper management of low and intermediate level radioactive waste and of spent radiation sources, especially the Radium needles or tubes, has received great importance in the radioactive waste management policy in Albania.

The essential objective of the management of radioactive waste and spent radioactive sources is the protection of mankind, the biosphere and the environment from the detrimental effects of nuclear radiation both now and in the future. Radioactive materials are extensively used in me industrial and research activities mainly related to medical, industrial and other studies and applications. Table 1 shows the radiation sources used in medicine and industry. Adequate management involves a series of steps which lead from the arising of the wastes to their safe disposal, steps which may include collection, segregation, treatment, volume reduction, conditioning, transport, interim storage and disposal.

Radium is an alkaline earth metal. It is the most alkaline of the group. Thus, its chemical properties are similar to that of Calcium. In the case of internal contamination, the skeleton is the target organ. Radium is very reactive with air nitrogen. The radium element has a density d of 5 g/l, a melting temperature T_m of 960 ^0C, a boiling temperature T_b of 1140 ^0C. Radium as an isotope is produced during the radioactive decay of ^{238}U. It is an α emitter and has a half-life T 1/ 2 of 1600 years.

Table 1: Radiation sources used in medical and industrial applications

Application	Radionuclide	Half life T 1/2	Source Activity	Equipment
Bone densitometry	I - 125	60 days	1 - 10 GBq	Mobile units
Manual Branchy Therapy	Cs – 137 Ra – 226 Co - 60	30 year 1600 year 5,3 year	50 – 500 MBq 30 – 300 MBq 50 – 500 MBq	Small portable sources
Teletherapy	Co – 60 Cs - 137	5, 3 year 30 year	50 - 1000 TBq 500 TBq	Fixed Installation
Industrial Radiography	Ir – 192 Co - 60	74 day 5,3 year	0,1 – 5 TBq 0,1 – 5 TBq	Often– portable unit
Moisture detector	Am/Be - 241 Ra - 226	433 year 1600 year	0,1 – 2 TBq 0,1 – 2 TBq	Portable units to measuremoistur e content/density of soil etc.
Research studies	Ra - 226	1600 year	30– 300 MBq	Calibration of dosimetric units

Most frequently. Radium-226 sources were used in the form of needles or tubes. Although Radium was expensive, its use in medicine was widespread. A number of Radium sources (12 needles and tubes are known) were distributed before any suitable control to register or license users was established in Albania. Nevertheless, the safe management of spent Radium sources is being undertaken.

2. Material and Methods

From 1955 until about 1985, the University Hospital Center (UHC) and the Geophysical-Geochemical Enterprises (GGE) in Albania have used ^{226}Ra, ^{60}Co and ^{137}Cs sources for medical and industrial purposes. During this period the variety of radiation sources used in medicine and industry has become very large. This also corresponds to the period, when in Albania, some form of regulatory control or documentation of radiation sources became more common. Thus, the Institute of Nuclear Physics (INP) has recorded the type and location of radiation sources in Albania since 1971, when the INP began its activities. Typical activities for medical/industrial needles and tubes range, from a few milligram to a few tens of milligram Radium (equivalent to a few tens to a few hundreds of MBq). Radium sources have been used in gauges, irradiation facilities, industrial radiography devices or for instrumental calibration, containing between 1 – 10 mg of ^{226}Ra. The sources are generally less than 40 mm long with a diameter of 3,3 mm. These small Radium sources irradiate very strongly: i.e. the contact dose rate for a needle of 4 MBq is 0,01 Sv/h. Over the time and thus during their storage, helium and radon pressure generates in the needle caving, increases progressively and the risk of loss of tightness of the source is significant. Thus, there is a great risk that the source can become contaminating after a certain time. The collection and management programme for used Radium sources, proposed by INP specialists to the National Authority Board (Radiation Protection Commission RPC) was largely inspired by the recommendation of the IAEA. The sources are principally old radiation therapeutic sources in the form of needles or tubes. The mean activity of these (12 pieces) Radium sources is 200 MBq and each source is 40 mm long and 1 – 3,2 mm in diameter.

2.1. *Identification of candidate sources for conditioning*

Characteristic data of the Radium sources (such as activity, date of calibration, results of tightness measurements, address of the owner) are recorded on a Registration Form No 1, which then accompanies the Radium source. This is a very important step and is often made difficult by lack of reliable information since those sources are old and without specific documentation. Before the sources are transported to INP, the conditioning of spent Radium sources in a type A package is made in compliance with IAEA recommendations.

Registration Form No 1

Received Spent Radium Source			
Identification No.	012 – 4 M	**Surface dose rate.**	0,01 Sv / h
Received date.	March 1995	**Notified Nuclide.**	Ra – 226
Origin.	Oil Company	**Original Activity.**	5 mg. equivalent Ra.
Weight of Cont.	20 Kg	**Production date.**	1968
Responsible Person.	Unknown	**Producer.**	Republic of China
Verification.		**Dose rate at 1 m.**	2,1 mSv / h
Date of measurements.	01. 02.2001	**Leakage.**	No, sweep test by cotton
Nuclide & Activity.	^{226}Ra; same	**Responsible Person.**	Luan Qafmolla
Note. Surface dose rate has been verified			

2.2. *Packaging of radium sources*

The waste packages should meet the special requirements following the waste management scheme applied, and in particular, the transport, storage and disposal conditions. The needles are placed in a stainless steel capsule, 60 mm high with diameter of about 5 mm. The test to verify that there is no contamination on the walls of the capsules was made. Conditioning in a type A package was an attractive option for INP, having a small number of spent Radium sources and wishing to provide additional security and containment. The procedure used by INP is based on the IAEA recommendations for the conditioning of low activity Radium needles, using activated carbon as the packing media to adsorb radon gas that may leak from the needles. In order to limit radiation to the fingers, distant tongues are used to perform manipulations on sources and capsules. As potentially required by the waste disposal acceptance criteria, the Radium containing capsule is re-encapsulated (without having to open the original capsule), as applicable, and then placed in the appropriate waste container. To prevent involuntary opening of loaded containers, it was equipped with a locking system. The average dose rate, at 1 m from the surface of the outer 200 l steel drum container, does not exceed 2.1 mSv/h.

A registration form (Registration Form No 2) was introduced at INP for each cemented waste drum and all available data of conditioned waste drums are registered in the inventory register of the RAIS programme in a Personal Computer of the Radioactive Waste (RAW) Laboratory. A file accompanies each container with pertinent information (filling, identification number and position of container, radioactivity, loading date, results of dose rate measurement on contact and 1 m from the container, position in interim storage facility). The new Interim Storage Facility is constructed in an uninhabited part of the territory of INP and radiation signs alert any person who may approach the building. The dimensions of this building are 17 x 16 x 4 meter. Three layers of standard 200 l drums can be stacked on each other.

Registration Form No 2

Cemented Drum with Radium Spent Sources				
Drum No.		5	**Cement used.**	100 kg
Date of Conditioning.		1. 02. 2001	**Sand used.**	0.180 m^3
Waste type & Amount.		Spent Radium Sources 12 pieces	**Admixture.**	
Nuclide	**Activity**	**Total Activity**		
Ra – 226	3 x 0,3 mg	0,9 mg Ra	**Mixture time.**	1 hour
Ra – 226	3 x 0,1 mg	0,3 mg Ra	**Weight.**	> 550 kg
Ra – 226	5 x 5 mg	25 mg Ra	**Surface dose rate.**	1 mR / h
Ra – 226	1 x 10 mg	10 mg Ra	**Dose rate at 1 m.**	60 μR / h
		36,2 mg Ra	**Surface Contamination.**	No
Drum Quality.		Inside surface painted	**Responsible person.**	Luan Qafmolla

3. Conclusions

In Albania there is an established national strategy for the management of spent radiation sources. Users of radioactive material are informed by INP in co-operation with RPC during the licensing phase that they must transfer their spent radiation sources and radioactive waste generated by their units to the National Spent Solid Sources Facility in INP. As a next step, all nuclear units operating in Albania will, with financial contributions, maintain all the activities relating to the management of radioactive waste, establishing the National Institute (INP) which is the responsible organ for all activities on the management of the dangerous materials. Methods used by INP to condition spent radiation, especially Radium sources are performed in compliance with the respective recommendations of the IAEA. Operational and transport safety is in place (tightness of the Radium sources and application of the ALARA principle). The necessary surveillance and inspection during interim storage is undertaken to provide confidence that waste packages remain intact and that their contents are fully identified at the time of final disposal, which may take place ten or more years after placement in interim storage.

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