SEALED RADIUM SOURCES CONDITIONING OPERATION IN GHANA

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ABSTRACT

Most African countries have been using radiation emitting devices and radioactive sources for the past three decades or more for the promotion, development, and utilization of the peaceful application of nuclear techniques for the benefit of their countries. Most of these sealed radiation sources have deteriorated to such a state that they are leaking and their current storage situation does not meet the necessary norms for safety.

This is due to the fact that most of the countries don't have radiation protection and waste management infrastructures. To this effect the Organization of African Unit (OAU) through the African Regional Co-operative Agreement (AFRA) have strongly endorsed the International Atomic Energy Agency (IAEA) awareness of the need to promote well defined levels of radiation protection and waste management especially in the handling and storage of spent radioactive sources. Since most countries lack facilities and trained personnel, a specialised team from South Africa has been established to encapsulate, condition and store all sources on the continent, thus clearing the continent of all dangerously neglected sources.

This paper presents an overview on the first mission operation carried out in Ghana by the team from South Africa together with the assistance of Ghanaian experts in encapsulating and conditioning of a total of 190mg of spent sealed radium sources.

INTRODUCTION

The African Regional Co-operative Agreement (AFRA) for research, development and training relating to nuclear science and technology is an inter-governmental agreement. It was established on April 4, 1990 from an initiative of several African Member States (AMS) who requested the International Atomic Energy Agency (IAEA) to help establish a regional arrangement for co-operation in the field of nuclear science and technology in Africa. At present, AFRA has a membership of 25 African countries, a field management which is taking gradual ownership of the program's conceptual design, planning, implementation and monitoring and a set of co-operative projects which fall under four themes in the fields of radiation safety, human health, agriculture and radiation technology [1].

During it's first five years (1990-1994), AFRA focused on regional capacity-building to enable scientists in all its Member States to acquire the necessary capacity which could stimulate the exchange of information and experience and facilitate the transfer of know-how from the advanced countries to the countries where the expertise is still needed. Efforts were therefore directed towards the optimal use of the facilities and expertise that exist in the region and the upgrading of infrastructures including the design and enforcement of new procedures and rules.

At the beginning of the second five-year term (1995-1999), the AFRA programme was audited by a group of experts who made some recommendations, including the necessity to re-orient the programme's efforts in order to respond in a more efficient manner to the priority needs of its Member States with particular emphasis on activities that are expected to lead to a visible impact and which can be sustained once AFRA's assistance is terminated. These recommendations prompted AMS to agree on a mission and strategy, which have reoriented the programme's efforts to need-driven and solutions-oriented activities that can optimize the utilization of available regional facilities and expertise and rationalize the programme's efforts by generating a new thematic approach to development issues.

To this effect the OAU and the IAEA share a high degree of awareness of the need to promote actions of radiation protection and waste management infrastructure in the region. The awareness was clearly shown on several occasions, particularly during the first OAU seminar on "Africa's Role in Nuclear Science and Development" and the second OAU seminar on " Radiation Protection and Waste Management", when the OAU strongly endorsed the IAEA awareness to maintain a well defined level of radiation protection, especially in the handling and storage of spent radioactive sources. In April 1998, in collaboration with AFRA and the OAU, AMS agreed on a strategy which includes the development of a regional capability and a sustainable mechanism for the safe handling, treatment, storage and disposal of all existing and future radioactive spent sources on the continent and through Technical Co-operation among Developing Countries (TCDC) with triangular funding arrangements. The first stage consists of clearing the continent of spent radium sources as these are seen as presenting the highest and most immediate potential risk. A specialized team from South Africa was formed to undertake this task [2].

This paper presents an overview of the specialised radium conditioning team and the first conditioning of spent sealed radium sources carried out in Accra, Ghana by the specialized team from South Africa together with the assistance of Ghanaian experts.

DUTIES AND RESPONSIBILITIES OF SPECIALISED TEAM

To benefit from the assistance of the specialized radium conditioning team, the recipient country should collect and characterise the radium sources and prepare a proper room for the conditioning operation as well as an interim storage facility. A radium source-conditioning project is then initiated by the Member State, requesting AFRA to undertake conditioning of spent radium sources in his country. Once an official request is received, a generic workplan is drafted and communicated to the nominated national counterpart of the requesting Member State. The information is also communicated to the team leader of the specialized radium conditioning team. A pre-mission by either the AFRA Technical Officer or the leader of the specialised team is undertaken to characterize the sources and check the designated operational area, the interim storage and advice the national counterpart. The expert carrying out the mission will also identify any equipment required and will document the status and all relevant information in his pre-mission report [2].

According to the report a country specific workplan is derived and communicated with all the parties involved and agreed upon. The workplan identifies all required actions, the required time, start and end date and responsible organisation/person. The specialised team, the Technical Officer and the national officer will carryout their obligations according to the approved workplan. The specialized team is made of a:

Radiation Protection Specialist - To monitor the conditioning operation to ascertain that the dose to the operators and the public is within the specified limits and that the ALARA principles are followed throughout the operation.

Team Leader - A trained person capable of operating all the facilities as well as the specialized welding equipment. This person must have a thorough knowledge of nuclear physics to be able to determining shielding requirements for the different sources that will be handled.

Technical Specialist -An expert in the re-encapsulating leaking sources and in welding techniques used in the manufacturing process of radioactive sources.

All members of the team should be certified to operate the equipment and documentation to be taken up in the quality system.

RADIUM SOURCES IN GHANA

Radium needles were been used at the Radium Therapy Centre (RTC) of the Komfo Anokye Teaching hospital (KATH) for the treatment of cervical cancer since 1992. Documentation available indicated there were 19 x 10-mg radium needles at the RTC [3]. Due to unfavourable characteristics of radium the IAEA, Ghana Atomic Energy Commission (GAEC) and KATH agreed that the radium sources be decommissioned and be replaced with a new caesuim-137 source. On March 11,1996 the 11x 10mg of the radium needles were decommissioned and transported to the Interim Storage facility of the National Radioactive Waste Management Centre (NRWMC). The rest of the 8x10mg sources were decommissioned on September 23,1997. The sources were placed in appropriate lead castles, which were in turn placed in their original containers (20 litre) used for shipment to Ghana. The inventory of the sources is shown in Table I. Two of the containers were marked K-24 and K-32. They each contained 4 needles of dimension 10mm long and 1.7mm diameter approximately. Wipe test carried out on individual needles indicated no leakage. The third container was not tested for internal contamination as report from RTC indicates that the needles are "fused" together and that the radon gas concentration is expected to be high. Since the radiation protection infrastructure was not suitable for handling leaking sources, no attempt was made to investigate the third container [4].

An IAEA technical officer, from August 17-18,1998, undertook a preparatory mission to Ghana. The importance of the mission emanates from the necessity to gather as much information as possible on the sources inventory and status as well as to approve the selected site and provide guidelines on site preparation. Two possible sites were proposed when requesting the assistance of the specialised team. During the preparatory mission, the first site was found to be inappropriate mainly due to poor floor quality, unrestricted personnel access and difficult access by forklift. The second site met most of the criteria established for conditioning operation. A site radiometric mapping was done with a doserate monitor to determine the background and was found to be suitable. The conditioning operation was scheduled for November 9 – 13, 1998. The team from the Atomic Energy Corporation of South Africa was nominated to undertake the conditioning operation [5].

QUALITY ASSURANCE PROGRAM

In order to accomplish the work with due reliability, a comprehensive quality assurance program was established and followed [6].

Written operational procedures were developed. These procedures refer to all major steps of the operation, as well as radiation protection aspects. They are, preparation of the concrete package, spent radium sources conditioning and capsule leakage testing. Included in the procedures is the description of the equipment and material (consumable and non-consumable) necessary to fulfill the applicable tasks.

All the dose rate and surface contamination monitors brought by the specialist team were calibrated and checked before use. A radium source was used for the dose rate monitor calibration.

Stainless tubes with external diameter of approximately 20mm for small and 48mm for big capsule, and a 3mm wall thickness was used to manufacture the body part of the capsules. The lids were made of 3mm plates. The capsules were manufactured prior to the mission in Ghana. During the mission, before the loaded capsules were welded, an empty capsule was also welded, to ensure that the weld settings are acceptable.

Table I: Source Inventory

Record on 1st Decommissioning (March 11, 1996)

Quantity	11x10mg
Source type	Radium needles (Ra-226)
Geometry and dimension	Cylindrical, 10mm long, 1,7mm diameter
Activity	4.07GBq
Dose rate at 1m from source package	0.04mSv/h
Date and results of last leak test	11 March 1996

❖ No leak tests were carried out.

Record on 2nd Decommissioning (September 23,1997)

Quantity	8x10mg
Source type	Radium needles (Ra-226)
Geometry and dimension	Cylindrical, 10mm long, 1,7mm diameter
Activity	1.48 GBq
Dose rate at 1m from source package	50µSv/h
Date and results of last leak test	23 September 1997

❖ Wipe tests were performed using cotton wool and checked with alpha contamination monitor. No alpha emitters were detected.

Labels on the containers are detailed below

K-24	K-32	3rd Container
Radioactive lll (Yellow)	Radioactive lll (Yellow)	Radioactive lll (Yellow)
Contents Ra – 226	Contents Ra – 226	Contents Ra – 226
Activity 1.48 GBq	Activity 1.48 GBq	Activity 4.07 GBq
UN Code 7	UN Code 7	UN Code 7
Gross weight 21.8kg	Gross weight 21.85 kg	Gross weight 48kg

Since the conditioned source inventory must be available during the whole storage period, the capsule, lead shield and concrete shield were painted with the following information as shown in Figure 1:

Capsules:

- Radioactive Material
- Ra – 226
- Activity: < 1.85 GBq
- Code: sequential number starting at 01
- Loading year: 1998

Lead Shield:

- Unique number: G1 where G represents Ghana and 1 indicating the first shield
- Numerical number identifying each hole in the shield (1 to 6)

Concrete Shield, Identification plate welded onto metal locking bars:

- Radioactive Material
- Nuclide: Ra-226 Encapsulated Sources
- Activity: 7.03 GBq
- Conditioning date: 1998 11 11
- Country/Place: Ghana, Accra
- Drum no: GA 01

Concrete shield (Painted on Drum Outer Surface)

- Ra – 226
- GAEC
- Radioactivity symbol
- Unique number: GA 01 indicating the first drum in (G)hana, (A)ccra

Fig.1: Writing On Lead Shield, Capsule And Concrete Shield

OPERATION DESCRIPTION

Before the operational area was set up, a radiological survey was done to characterize the area. The area was covered with plastic and a radiological supervised area was designated. The transfer area was erected with lead bricks and lead glass for shielding. A ventilation system (HEPA filter system) was installed above the transfer area.

The shields with sources were transferred one at a time from their original storage site to the conditioning room checkpoint where their surface dose rate was measured and recorded. The shield was then directly moved to the capsule loading area, where the sources were transferred to the stainless steel capsules. The activity of the capsule was estimated by the dose rate at 1m distance, using the conversion for Ra-226, 0,01mSv/h = 1mg. The dose rate measurements obtained during the loading of the capsules are indicated in Table II. All the sources were sealed in four stainless steel capsules, two standard and two big capsules. The sources placed in the standard capsules were about 10mm long and 2mm diameter. The source loaded in big capsule 03 was the one referred to as "fused together" in the pre-mission inventory description, this was actually a tube

50mm long and 6mm diameter. The source loaded into big capsule 04 was a disk, 20mm diameter and 6mm thick. None of these sources leaked.

Table II: Summary of sources loaded.

Capsule number	Original shield no.	No.	Dose rate measurement at 1m in µSv/h	Individual dose rate µSv/h	Assumed activity (mg)
01-std	K-24	1	100	100	10
		2	165	65	10
		3	242	77	10
		4	330	88	10
	K-32	5	400	70	10
		6	480	80	10
02-std		1	95	95	10
		2	185	90	10
03-std	Third unnumbered shield	1	750	750	80
04- std		1	280	280	30

Once the capsule was loaded, it was transferred to the welding area, where the lid was placed into position, welded and cooled and submitted to leakage test. No capsule failed the leak test. The leak test was performed according to standard ISO 9978. The capsule finally transferred to the appropriate cavity of the final shielding device. The capsules were placed in such a way to avoid dose rate concentration in one region. The capsule information is given in Table III.

Before the concrete package was closed, two measures were taken to protect the sources against unintentional or unauthorized opening. Firstly, the securing screws and lid of the lead-shielding device were welded together and secondly, steel bars were welded together across the concrete package cavity hole.

As a result of the mission, a total of 190mg (approximately 7.03 GBq) of radium was safely conditioned according to the established quality assurance program. All the sources were sealed in four stainless steel capsules, which were conditioned in one shielding device. One concrete package was produced and identified by GA-01. The local nuclear authority, the IAEA technical officer and the team leader signed a protocol stating the conditioned inventory.

Table III: Capsule Information Form

Packaging ID	Shielding ID	Capsule ID	Hole no in Shield	Activity (mg)	Number of sources & description	Date of measurement
GA 01	G 1	01	1	60	6 x Ra-needle	11–11– 1998
		02	2	20	2 x Ra-needle	11-11-1998
		04	3	30	1 x Ra- needle	11-11-1998
		-	4	-	-	-
		08	5	80	1 x Ra-needle	11-11-1998
		-	6	-	-	-
		Total Activity		190		11-11-1998

Package Information Form

Package ID	Activity (mg)	Surface dose rate (μSv/h)	Dose rate at 1m distance (μSv/h)	Date of measurement
GA 01	190	250	5	11-11-1998
Total Activity:	190			

DISPOSAL OPTION

In the short term, as practical solutions and safe technologies are being introduced to solve problems created by radioactive waste from the use of radioactive materials, a long term disposal option is being developed. As part of an International Atomic Energy Agency (IAEA) programme to strengthen waste management infrastructure in African countries (AFRA I-14), an IAEA Technical Corporation (TC) Project has been awarded to the Atomic Energy Corporation of South Africa Ltd. (AEC) to investigate the Borehole disposal Of Spent Sources (BOSS) disposal concept. The objective of the project is to validate the technical feasibility and economic viability of the concept to be used for the safe disposal of radioactive spent sources. The introduction of the "bore hole disposal" technology to other AMS will be accomplished with assistance of specialized teams drawn from AMS. The team will assist in the planning and drilling of the boreholes. They will oversee the training of national core group in the use of these facilities.

CONCLUSION

Safe management of radioactive waste requires the existence of a legislation, which gives the legal base for requirements and responsibilities. Over the past 10 years AFRA with assistance from the IAEA have been trying to establish legal frameworks for the regulation of nuclear activities in AMS. These include the promulgation of legislation on radiation protection and waste management and the establishment of technical centers to enforce the regulations and to promote safe use of nuclear techniques for socio-economic development. Although considerable efforts have been invested to achieve this objective, the present situation cannot be considered satisfactory.

The present status of radiation safety in Africa calls for urgent actions to further increase the awareness and the commitment of the countries in the region by reaching the real decision-makers. So that the momentum created can lead to concrete improvements. To this effect, concerted efforts by the OAU, IAEA and AFRA are being deployed to upgrade radiation protection and waste management infrastructure in the region, with particular emphasis on the promulgation and enforcement of radiation protection legislation and regulations.

Success in the peaceful deployment of nuclear technologies will have a social impact in enhancing the general peaceful interaction and respect between the people of fellow States of the African continent.

REFERENCE

[1] A Decade African Regional Co-operative Agreement, 1990-1999, IAEA, Cairo, 1999

[2] AFRA Specialized Team for Conditioning of Radium Sources, Draft Guidelines, February, 1998

[3] Report on Decommissioning of Radium Sources at the Radium Therapy Unit of the Komfo Anokye Teaching Hospital, March, 1996

[4] Report on Decommissioning of Radium Sources at the Radium Therapy Unit of the Komfo Anokye Teaching Hospital, September, 1997

[5] Al-Mughrabi M, Expert Mission Report, Radium Sources Conditioning in Ghana, August,1998

[6] Hordijk L, Expert Mission Report, Radium Sources Conditioning in Ghana, February 1999