NATIONAL WASTE MANAGEMENT INFRASTRUCTURE FOR THE SAFE MANAGEMENT OF RADIOACTIVE WASTE IN GHANA

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ABSTRACT

As in many developing countries the use of nuclear techniques is growing considerably in importance within the national economy of Ghana. With the operation of a nuclear research reactor, gamma irradiation facility, radiotherapy and nuclear medicine facilities in Ghana, the need to establish commensurate infrastructure for radioactive waste management has been recognized.

This paper highlights the steps that has been taken to develop a systemic approach to the development of the national waste management infrastructure which consist of regulations, training of requisite manpower and provision of equipment to cope with the anticipated waste to be generated and those already in existence.

INTRODUCTION

Work with radioisotope in Ghana started in 1952. It had its beginning in the University College of the Gold Coast (now the University of Ghana) where the initial experiment carried out involved the application of radiostrontium on monkeys. Following the success of these initial investigations, interest in radioisotope application grew, with it, a general awareness in the country's potentialities of radioisotope techniques and ionizing radiation as a tool for scientific research.

In 1963 the Ghana Atomic Energy Commission (GAEC) was established by an Act of Parliament (204) to promote and develop the peaceful application of nuclear techniques for the benefit of Ghana [1]. Due to developmental growth in the country, use of radioactive materials spread to cover areas of agriculture, hydrology, medicine, research and industry. The Ghana Government through the GAEC recognizing the need to establish the basic requirement for the protection of people and the environment against undue radiation exposure established the Radiation Protection Board (RPB) as the sole regulatory authority. It was empowered with the Radiation Protection Instrument LI 1559 that was promulgated in January 1993 [2].

Increasing awareness of the existence of spent radiation sources in the fields of medicine, industry, research and teaching with the operation of a research reactor, a gamma irradiator and large nuclear medicine and radiotherapy centres has necessitated the need for a comprehensive waste management infrastructure in Ghana. The LI 1559 provides minimum legal basis for regulatory control of radioactive waste management. However, it does not exclude necessity for adopting the regulations on radioactive waste management since it deals with waste management issues in a very general way and cannot be of practical use by numerous waste producers. In

order for the total control of radiation sources and radioactive materials from 'birth' to the 'grave' a comprehensive radioactive waste management regulations was initiated under International Atomic Energy Agency (IAEA) model project and African Regional Cooperation Agreement (AFRA-1) project. A central waste management facility, National Radioactive Waste Management Centre (NRWMC) which will be responsible for the management of all radioactive waste generated in the country was established.

The first phase of the NRWMC programme covers establishment of administrative structures, development of regulations and development and construction of radioactive waste processing and storage facility for the treatment, conditioning and storage of radioactive waste. In the second phase a central waste repository shall be developed and put in operation, for the final disposal of radioactive waste [3].

WASTE EXISTING AND EXPECTED

Presently radioactive waste is generated from research, medical and industrial use of radionuclides. Records available indicate that there are more than 15 institutions in Ghana utilizing radioactive materials. The largest individual waste generator is the National Nuclear Research Institute (NNRI). Its main waste generating activities are, radiotherapy and nuclear medicine, pesticide research, radiopharmacy, neutron activation analysis and from the gamma irradiation facility.

In the medical field radionuclides Tl-204, Ir-192, I-125 and Tc-99m among others were used as open sources. Ra-226 needles were used in brachytherapy at Komfo Anokye Teaching hospital. The Ra needles have been conditioned with the help of an AFRA specialized team from South Africa with the aid of the IAEA. In the field of research, Co-60 is being used for irradiation and calibration. Am-Be is being used in neutron activation studies. The research activities also generate P-32, C-14, H-3 and S-35 wastes. In the industries Ir-192 is being used for gauging, Sr-90 for thickness measurement and Am-241 + Cs-137 for well logging. The activities of the waste generated currently range from a few Bq to GBq [4]. The inventory of waste in existence in storage is shown in table 1.

With the increasing use of radioactive materials and the establishment of nuclear and large irradiation facilities, the amount of waste to be generated will increase. Radioactive waste from these facilities will include spent ion exchange resins from the nuclear reactor water purification system, incompatible solid waste from mechanical filters, liquid and organic waste, spent fuel from the nuclear reactor and spent sealed sources made up of between 185GBq and1.85 PBq of Co-60. It is estimated that seven 200L drums will be needed annually to condition the waste to be generated [5].

Table 1: Inventory of radiation sources in Ghana.

Isotope	No of Sources	Activity per Source (Ci)	Total Activity (Ci)
^{60}Co	1	5.0000E+3	5.0000E+3
	1	7.5000E+3	7.5000E+3
	1	5.0000E+4	5.0000E+4
	1	2.9729E+2	2.9729E+2
	1	1.0000E-1	1.0000E-1
^{137}Cs	5	4.4860E-1	2.2432E+0
	2	8.1081E-3	1.6216E-2
	4	2.1297E+0	8.5189E+0
	7	2.000E-2	1.4000E-1
	1	1.0000E-1	1.0000E-1
	2	2.0020E+2	4.0040E+2
	2	2.0000E+0	4.0000E+0
^{241}Am	2	4.0540E-2	8.1081E-2
	3	2.0000E+1	6.0000E+1
	1	4.0000E-2	4.0000E-2
	1	1.0000E-2	1.0000E-2
	1	3.0000E-2	3.0000E-2
	1	1.0000E-2	1.0000E-2
^{90}Sr	28	2.0000E-2	5.6000E-1
	1	5.0000E-4	5.0000E-4
^{109}Cd	4	3.0000E-3	1.2000E-2
^{192}Ir	1	6.3243E+2	6.3243E+2
	1	2.9729E+3	2.9729E+3
^{226}Ra	19	10(mg)	190(mg)
^{252}Cf	6	2.0000E-2	1.2000E-1
^{113m}In	12	5.0000E-2	6.0000E-1
^{99m}Tc	77	1.3500E-1	1.0395E+1
^{59}Fe	2	2.0000E-1	4.000E-1
^{32}P	1	1.0000E-2	1.0000E-2
^{89Sr}	1	1.2900E-1	1.290E-1
^{57}Co	1	1.0000E-2	1.000E-2
^{204}Tl	2	1.0000E-3	2.0000E-2

RADIOACTIVE WASTE MANAGEMENT INFRASTRUCTURE

Legislative framework

The Ghanaian legislation regulating use of radioactive materials is based on Act (204) which established GAEC and Radiation Protection Instrument LI 1559 (1993) defining the role of the Radiation Protection Board (RPB) [1,2]. Within International Atomic Energy Agency (IAEA) model project INT/9/144 and the African Regional Cooperation Agreement (AFRA) project, a new regulation aimed at radioactive waste management has been drafted. The initial draft was reviewed by the RPB [6]. A national seminar on the Understanding and Implementation of the Regulations on Radioactive Waste Management in Ghana was held on 9 – 11 October 1996.

Twenty-five (25) persons from various Ministries, Agencies, and the General public attended. The final outcome of the draft regulation with comments from the seminar delegates and an IAEA expert was sent to the Attorney General's office for the necessary legal touch. The drafted regulation is receiving government's attention for promulgation. The guidelines for the implementation of the regulation will be complete by a set of 18 practical Guidelines and Codes of Practice [7]. Prior to the promulgation of the LI1559, NNRI the oldest institute of GAEC was the responsible organization for the management of the waste.

Responsibilities and Administrative Measures

The regulation is based on a separation of responsibilities between the operating organization (NRWMC), waste generators and the regulatory body (RPB). The primary responsibility for safe management of wastes rests with the waste generator unless the responsibility has been transferred to the NRWMC. The waste generator is responsible for on site segregation, collection, characterization and temporary storage of the waste arising from his activities.

The NRWMC is the designated national centralized facility. It will have the requisite facilities for the treatment, conditioning and storage until a final disposal facility is established and made operational. The NRWMC takes control of the waste where the generator is incapable of handling the waste or the generator no longer exists.

The RPB is responsible for the enforcement of compliance with the provisions of the waste management regulations and all other relevant requirements by the waste generators and the NRWMC and the implementation of the licensing process for generation and management of radioactive waste.

Waste Handling Practices

The regulations prescribe the regulatory requirements on the various aspects of waste management operations covering; segregation to storage. NRWMC staff will do collection of waste from waste generators. All waste that is not likely to decay to clearance level within one year will be transported to the NRWMC. A light truck shall do transportation, with arrangement for waste fixation. All waste shall be accompanied by a document with detailed characterization. Primary control of waste to check for acceptance criteria by the NRWMC staff will be done at the waste generation site. At the waste processing facility an additional control and analysis will be done, especially if needed for treatment and processing purposes. Decay storage is considered for short-lived low activity spent sources that will decay to clearance levels. The conditioned waste is expected to meet the waste acceptance criteria being developed by the NRWMC before storage. From the point of view of technological requirements, the cemented waste shall be stored in the waste processing facility minimally for 24 hours, before its transport to the storage facility.

RESOURCES FOR WASTE MANAGEMENT

In addition to legislative background safe radioactive waste management needs human and technical resources.

Manpower

Human resource is an essential prerequisite in enforcing the requirements of the regulations. The operational functions of the radioactive waste management are executed with 11members of radioactive waste management working group. Two of the members are permanent staff of the Centre. The rest of the members are staff from the various institutions of the GAEC. They have all participated in most IAEA inter-regional and AFRA regional training course in waste management. The administrative staff is under the general administration of the GAEC. The organizational structure of the centre is provided in figure 1.

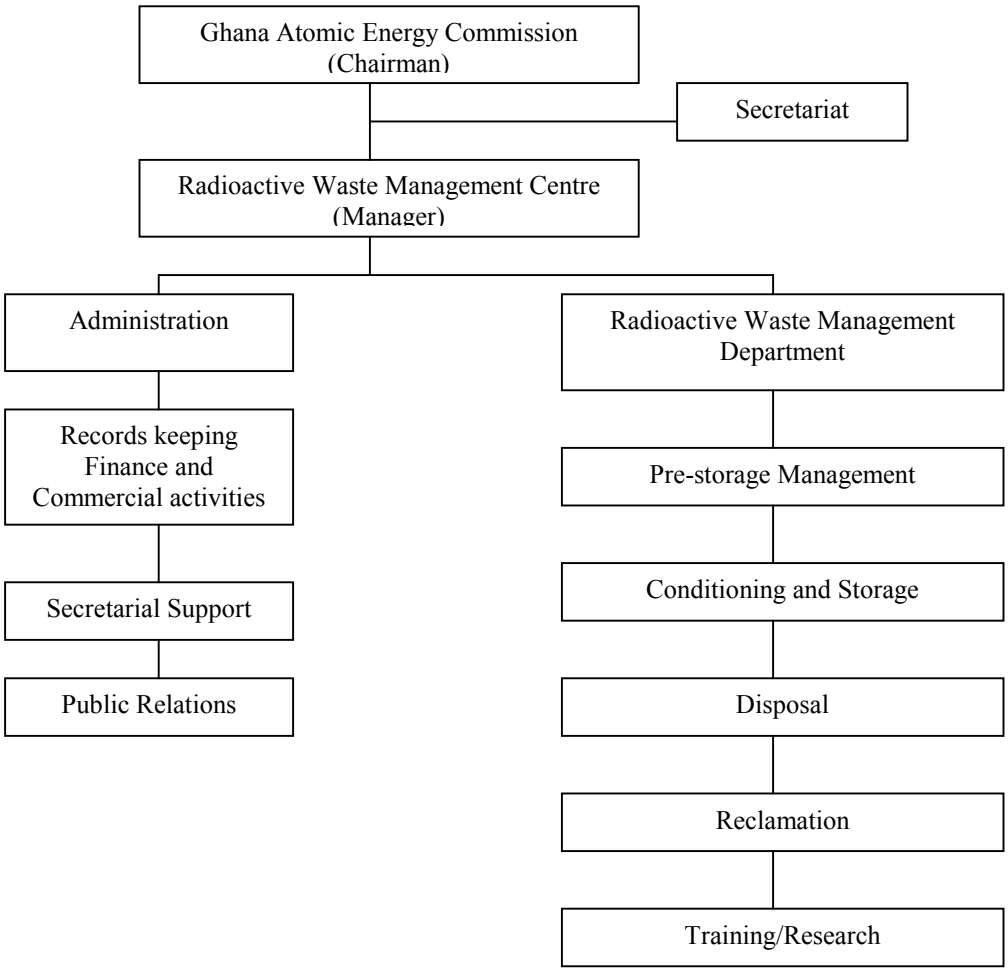

Fig. 1: Organizational Structure of the Radioactive Waste Management Centre

Training and retraining of staff are very important in maintaining high standards of safety and upgrading of knowledge and skills in radioactive waste management. With the completion of the Central Waste Processing and Storage facility, more permanent staff will be recruited for the Centre. Training should be bound to the planned delivery of technological equipment and measuring devices for the Centre. The staff should be encouraged to participate in various training programmes both locally and internationally.

Technical Resources

It was recognized quite early in Ghana's nuclear programme that safe management of radioactive waste is vital for its success. In view of this, a system of waste storage and processing facilities were constructed for the planned 2MW-research reactor that was never built. It consist of a decontamination unit(8 x 6m and height 6m), two concrete vaults (about 5 x 15 m and 4 m deep) intended for low and intermediate level waste storage and three rows of concrete wells (about 0.5 m diameter x 4.6 m) for storage of spent fuel. Safety and performance assessments of these facilities have been carried out with the help of IAEA experts to ascertain their suitability for waste processing and storage. The assessment indicated that the decontamination unit and the wells are still in good conditions and are therefore under refurbishment for use as waste processing and storage facilities. The rehabilitation work commenced in the latter part of 1998 and is expected to be completed by 2000. A new storage facility (6 x 5m, height 3,5m) with a capacity of 100 200L drums is also being constructed to compliment the existing structures. This new facility is in line with the current trends in nuclear technology development in the country. A laboratory is also being established to carry out leaching studies. The NRWMC has an interim storage facility, which consist of a concrete building with a room of 6.15 m x 3 m in dimension.

Further the Centre is developing with the help of an IAEA software a comprehensive national programme for the management of spent sealed sources. The programme includes the following components:

- Means for usage of the Sealed Radiation Source Registry as a tool for the control of spent sealed sources.
- Organization and development of methods for collection and transportation of spent radiation sources to the Centre.
- To identify and register all previously unaccounted for sources.

CONCLUSION

Even though Ghana has a very modest scale of application of radiation sources there is the need to lay a solid foundation and safety culture for protection against harmful effects of ionizing radiation. Promulgation of the National Radioactive Waste regulations and the relevant supporting document as well as the establishment of the Central Waste Processing and Storage Facility will provide the needed foundation to ensure waste safety in the country. Quality assurance and control systems are being developed to guide the operators of the waste management facilities. A basic operational laboratory shall be installed.

With the expected completion of the Central Processing and Storage facility by 2000. The second phase of the Waste Management programme will begin with the development of the wells to store the spent fuel that will be generated from our research reactor. Performance analysis of this facility will need full hydrogeological and geological description of the site. This we hope to do with the help of the Geological Survey Department (geophysical investigation), Water Research Institute of the Council for Scientific and Industrial Research (CSIR) and the Hydro-Division of the Architectural and Engineering Services Corporation. It is highly probably

that despite all these institutions, the help of foreign expertise will be needed. These studies will the first stage in our site selection programme for the development of a near surface disposal facility for the disposal of radioactive waste.

Furthermore the Ghanaian Parliament has approved the ratification of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste. This indicates the support of the Ghana Government for the NRWMC activities.

With the anticipated commensurate support from the Government of Ghana through GAEC and the assistance from IAEA/AFRA in the form of scientific equipment, training programmes for staff and expert visits, the NRWMC will develop infrastructure for safe management of radioactive waste.

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