

**Experience of Consolidation Of Disused Sources In Developing Countries,
An African Perspective - 8442**

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ABSTRACT

Application of sealed sources in agriculture, medicine and industry was used in many African countries without having any arrangements in place for managing the sources when their useful life was over. In Tanzania a substantial use of such sources was utilized. In the early days source management was not an area that was given the required attention hence a legacy associated with sealed sources became evident in many African countries and Tanzania was one of them. In the 90s Tanzania Atomic Energy Commission (TAEC), realized the scope of the waste problem and began to participate in an International Atomic Energy Agency Regional (IAEA) project on waste management. Tanzania in cooperation with IAEA initiated activities under the IAEA Technical Cooperation and the Regional projects “Strengthening Waste Management Infrastructure, RAF/4/015”; and “Sustaining the Waste Management Infrastructure RAF/3/005” which played a significant role. The first outcome of the project was realized in 1999, as the first “Temporary Radioactive Waste Storage Facility” began to operate. This particular Storage facility gave the first impact as well as the need to develop this particular infrastructure further. As the project carried on, more and more orphan sources were recovered, collected and safely stored at the facility.

As the use of nuclear technology was expanding and the identification of the extent of sealed sources in the countries became more defined, the need to develop a “Central Radioactive Waste Management Facility” (CRWMF) was becoming more desired. The central radioactive waste storage facility was constructed and commissioned in 2005. The facility was more advanced and could be used for much longer periods of time, as one of the most advanced storage facility in the Region.

At present a large number of disused sources from various industries as well as from different activities are being stored at the facility. Tanzanian authorities are also planning to initiate a nationwide mission to recover and properly store as well as dispose of abandoned sources. Cooperation among the AFRA Member states has been very rewarding in terms of experience and its importance. Skills that have been gained during the past years of existence of the AFRA project will be a vital contribution for years to come. This paper discusses the experiences of United Republic of Tanzania on management of orphan radioactive sources. The need to develop its own radioactive waste management infrastructure was required due to the fact, that many disused radioactive sources have been found abandoned and needed to be properly disposed of. The paper will also discuss some of these experiences.

INTRODUCTION

Radioactive materials in the form of sealed sources and various nuclear techniques in general were used in many African countries for more than four decades without any legislation to ensure their control and safe management when their useful life was over.

The legislation for the control of ionizing radiation in the United Republic of Tanzania was first enacted in 1983 through the “Protection from Radiation Act, No. 5, 1983”. Even with this development, a sound radioactive waste management infrastructure and capability could not be developed until 1993 when

initiatives to establish, a radioactive waste management infrastructure and capability started to be implemented through an “African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology” (AFRA) regional project on waste management and in particular after it was observed that many disused radioactive sources have been abandoned and in most cases, the institutions which possessed them did not have the means and capability of disposing of the sources in accordance with the recommended waste management standards. Through the IAEA supported Regional project RAF/4/015, Tanzania became extensively involved in the development of the regulatory infrastructure, including the development of radioactive waste management infrastructure and capability in line with AFRA radioactive waste management activities. As a result of these developments, the United Republic of Tanzania enacted the regulations for waste management in 1999, and there-after initiated the installation of a temporary waste management facility. Efforts to construct a central radioactive waste management facility started in 2000 and by the year 2005 the central storage facility had been completed and was commissioned for use in the same year. Sources previously stored in the temporary storage facility and also disused sources that were removed from the public domain were transferred to this facility to ensure safety and security.

This evaluation involved establishment of the regulatory framework, management of spent and disused sources, maintenance of radioactive sources inventories, collection of spent and disused sources, scrap metal monitoring, search of orphan sources, control of illicit trafficking of nuclear and other radioactive materials and project activities pertaining to radioactive waste management in which Tanzania is participating.

LEGISLATIVE AND REGULATORY FRAMEWORK

Legislative Framework

The control of radioactive sources in the United Republic of Tanzania is governed by the Atomic Energy Act No. 7 of 2003, which repealed the former Protection From Radiation Act No. 5 of 1983 [1]. The legislation provides for legal framework for the protection of individuals, public and the environment from radiation hazards by establishing and maintaining an effective safety and security control of radioactive materials used in the country. From the Act No.5 of 1983, which was repealed by the Atomic Energy Act No. 7 of 2003, the Radioactive Waste Management Regulations were promulgated. The regulations aimed to ensure the protection of human health and the environment [2]. These regulations, which consist of seven parts, set up the basic technical and organizational requirements to be complied with by waste generators and operators of waste management facilities. On going amendment of the Waste Management Regulations will take care of the drawbacks of each part to ensure that the risks of disused sources are minimized. The improvement will incorporate:

- The necessity by Registrants and Licensees to provide the required documents and guarantee for disposal of the sources when their useful life was over.
- As for the new sources to be imported, evidence of the arrangements for disposal of the sources before registration and licenses are granted. Such arrangements may include a disposal contract between the user and the supplier or with the Tanzania Atomic Energy Commission upon request.
- Introducing a decommissioning license, which will require waste generators to make sure the radioactive waste on the sites is at all times adequately controlled, or contained, so that it can not leak or escape from control before being transported to the TAEC central storage facility.

The United Republic of Tanzania further intensified her efforts to strengthen the waste management regime by establishing the Atomic Energy (Protection from ionizing Radiation) Regulations 2004.

These regulations revoked and replaced the Protection from Radiation (Code of Practice) Regulations 1990 [3] and they specify the minimum requirements for the protection of people against exposure to ionizing radiation and for the safety and security of radiation sources. The regulations also require Registrants or Licensees to ensure the safety and security of the sources under their responsibility, from the moment of their acquisition throughout their entire operational life and up to their final disposal.

Regulatory Framework

The Tanzania Atomic Energy Commission (TAEC) which is the official government body responsible for all atomic energy matters in Tanzania was established by the Tanzania Atomic Energy Act No. 7 of 2003 [1]. The Commission took over all the responsibilities and functions of the former National Radiation Commission that was earlier established from the Protection from Radiation Act No. 5 1983 but with some added responsibilities and functions. The main functions and responsibilities of the newly formed Commission (TAEC) are:-

- be responsible for all matters relating to the safe and peaceful use of atomic energy and nuclear technology including radioactive materials and radiation devices, with a view to ensuring the promotion of their applications and the protection of workers, patients and the public generally from harm resulting from radiation
- establish and operationalize or implement a system for the control and authorization through registration and licensing of the importation, exportation, movement, possession or use of atomic energy and radiation sources;
- carry out regulatory inspections and ensure that corrective actions are taken if unsafe or potentially unsafe conditions are detected;

MANAGEMENT OF DISUSED SOURCES

Having observed an increased use of nuclear technology which consequently resulted into having many sealed radiation sources of which their useful time was over and that the various institutions which possessed them did not have the capability to dispose of the disused sources safely, the Tanzania Atomic Energy Commission (TAEC) became extensively involved in the development of a national radioactive waste management infrastructure and capability.

Establishment Of The Temporary Storage Facility

The Commission procured a “Temporary Radioactive Waste Storage Facility” which was basically a 30 feet ISO container (Figure 1) in which most of the spent radioactive sources collected from various parts of the country were safely stored.



Fig. 1. The Temporary Radioactive Waste Management Facility used from 1999-2005

Some of the disused sources collected included thirty one radium needles with appr. total activity of 3.4 GBq (95 mg) previously used for brachytherapy in the 1960's, which were later conditioned with the assistance of the International Atomic Energy Agency (IAEA) recruited experts and stored in this Facility. In parallel with this also sources seized by the Police during incidents of illicit trafficking of radioactive materials were also brought to this temporary storage facility for storage.

Establishments Of the Central Radioactive Waste Management Facility, (CRWMF).

Efforts by the Commission to solicit funds for the construction of a dedicated "Central Radioactive Waste Management Facility" (CRWMF) started in 1999; and by 2005 the central storage facility which was constructed in the out skirts of Arusha municipality had been completed and was commissioned in the same year. Most of the thick walls including those partitioning the rooms of the Facility are constructed of special reinforced concrete designed to provide shielding to the disused radioactive sources that are to be stored in the Facility. Essentially the Facility has spacious rooms specifically designated for: receipt, delay and decay, operational area, storage of high activity sources, fume hood and a room for the storage of conditioned radioactive sources. In this storage room, up to 150, two hundred liter drums, can be satisfactorily stacked while allowing space for the movement of personnel and a small size fork lift for manipulation of the drums. In addition there is also an office, a physics room and shelves for staff to store facility equipment and related work tools. There are also shower rooms and toilets for normal use or in case of decontamination.

The CRWMF is a single floor building with approximately 380 square meters (see Figure 2) with steel trusses.



Fig. 2. The Central Radioactive Waste Management Facility commissioned in 2005

Physical security is provided by guards on site for 24 hours and also electronic alarms have been installed to deter burglary or unauthorized entry into the facility. In addition to the aforementioned measures, the safety and security of the spent sources in the facility have been enhanced by installation of a radio communication facility in order to ensure prompt communication between the Commission staff and security guards at the facility.

The completion and commissioning of this Facility paved the way to a better radioactive waste management regime in the country.

Disused/spent radioactive sources, which were stored at the “Temporary Radioactive Waste Storage Facility”, and also other spent sources removed from the public domain were safely transferred to the central storage facility in 2005 awaiting conditioning for their safe and long term storage.

Furthermore in 2005 with the assistance of the IAEA recruited experts, radioactive sources imbedded in walls at two old radiotherapy units (Muhimbili National Hospital and Ocean Road Cancer Institute) were also recovered and transferred to the CRWMF for safe storage. The sources from these two Centers are Spent High Activity Radioactive Sources (SHARS) which were abandoned after their useful life was over. Also during the same mission, other SHARS that were previously used for sterile insect technique (SIT) were also collected and transferred to this CRWMF for storage.

Already a large number of disused sources from various industries as well as strong spent and disused irradiators and radiotherapy sources were removed from the public domain and brought to the CRWMF awaiting conditioning. Arrangements have also been made for the SHARS sources in the CRWMF to be conditioned and be kept in a “Long Term Storage Shield” that has been specially designed by the South

African Nuclear Energy Corporation Ltd. (Necsa) and approved by a team of experts of waste management facilities. With the support of the IAEA, the United republic of Tanzania in cooperation with experts from the Nuclear Energy Corporation of South Africa (Necsa) will perform conditioning of the spent sources stored in the central storage facility in the second quarter of 2008.

Inventory of Disused Sources and Sources in Use

Inventorying means a campaign to physical check all sources possessed by specifically and uniquely identifying each individual source using appropriate means such as serial numbers [4]. The Commission maintains inventories of both sources in use [5] and also disused sources.

Sources in use and spent/disused sources are recorded both in hard copy and also in electronic form. Spread sheets (Microsoft excels) are used in terms of electronics form. The two inventories are updated during radiation safety inspections and licensing processes. As for the disused sources a program of inspections is implemented once a year to assess the integrity of the disused sources and also to verify the safety and security of the spent source.

The Commission also maintains a separate inventory of incidents of illicit trafficking of radioactive materials. Sources seized during illicit trafficking incidents are incorporated in the inventory of disused sources. Specific staff have been assigned to update these inventories regularly.

Collection of Disused Sources

From both safety and security point of view, all disused sources must undergo proper disposition [6]. Already a large number of spent and disused sources have been collected from various premises in the country and transferred to the central storage facility.

Only a few disused sources including four neutron sources are still in user's premises and arrangements are being made in cooperation with the respective centers owning them to have them transferred to the central storage facility for conditioning and long term storage.

Some of these disused sources include four neutron sources i.e. Am/Be-241, 185GBq (5Ci) for activation analysis and three Am/Be-241, 3.7 GBq (100mCi) each for moisture gauges.

Scrap Metal Monitoring

In Tanzania there is a need for scrap metal industries to be monitored as the application of radioactive sources started in 1940s, before the existence of a regulatory authority [7]. Moreover in Tanzania scrap metals are cheaper to be used by metal industries when compared to imported iron. Therefore, the possibility of spent/disused sources to be collected and entered into scrap metal industries is high.

Previous experiences provide evidence for incidences of melted radiation sources in metal industry such as in Goiania Brazil and Juarez Mexico [8,9]. In recognition of this fact, monitoring in two scrap metal industries based in Dar Es Salaam (the capital city of Tanzania) was conducted in October 2004. The two searches yielded no discovery of radioactive sources or contamination. However though from the year 2005 the TAEC decided to embark on a program for regular monitoring/searches of possible disused sources and provision of education to scrap metal industries in order to avoid such an incident as that one

which occurred in Goiania, Brazil and caused four deaths and wide spread contamination of radioactive material.

Search of Orphan Sources

The Regulatory Authority for the use of ionizing radiation was established in the United Republic of Tanzania in 1983, four decades after the application of radioactive sources was already in use. Due to this fact, many sources, which were in use in various applications, had not been licensed or registered. The Commission therefore initiated a pilot program of search and secure of disused/orphan sources. For example:

- In 1996 a source of (Cs-137) which was used as in industrial radiography was recovered from a swamp at TAZAMA Pipeline Company in Dar Es Salaam;
- Three other disused sources (Cs-137) which were used as density gauges were discovered at Williamson Diamond Mining Company in 2002;
- In 2005, five companies were found to have imported radiation sources without importation license;
- In the year 2003 three neutron sources, each of 3.7 GBq (100 mCi) were recovered from a drilling company;
- Also early in the year 2007, three disused sources (Am/Be-241) were recovered from a road construction Company in Dar Es Salaam.

Based on the outcome of the four searches which yielded the discovery of the orphan sources specified above, more searches are being planned by TAEC in order to ensure that, before the exercise of conditioning disused sources stored in the central facility, all institutes, industries and other possible areas of which its activities require the possibility of application of radioactive sources have been identified, visited and searched.

Control of Illicit Trafficking Incidents

The United Republic of Tanzania is among the African states where a number of illicit trafficking cases of radioactive materials have occurred and reported to the IAEA-Illicit Trafficking Data Base programme.

Lack of proper identification of key problem, which leads to theft or illicit trafficking of radioactive materials, is a set back for formulating strategies to properly maintain the security of radioactive materials and preventing theft or illicit trafficking [2]. In Tanzania, 13 incidents of illicit trafficking of radioactive materials have been recorded between 1996 to January 2007. Of these thirteen incidents, only two of them have involved the customs authorities. The two incidents are the ones relating to the detection of the shipment containing gas mantles in 2000 and the one of 2003 regarding unauthorized exportation of a gamma industrial radiography source for non-destructive testing. The remaining incidents involved illegal possession and sale of nuclear and/or radioactive materials of which their country of origin is not yet known. The problem of illicit trafficking was identified as:

- Radioactive sources, which are outside the regulatory control because they were not registered or not known;
- Inadequate or lack of proper security at user's premises;
- Low public awareness of radiation hazards and assistance to reveal the secret movements and sell of radioactive sources;

- Inadequate and at times lack of equipment and proper training of officials at border entries and exits points to identify radioactive/nuclear materials
- Tanzania is bordering nine landlocked countries and that its borders which is more than 1000 km is a big challenge to the Customs and Security officers to exercise control on movement of goods along the various porous border crossing points [10].

Following the work plan 2003-2007 of the project RAF/0/021 on nuclear security and the increased trend of illicit trafficking incidents in the URT, the IAEA organized a fact-finding mission in 2007 aimed at collecting information on cases of illicit trafficking and other unauthorized activities involving nuclear and other radioactive materials so that the information collected could serve as basis for needs assessment and subsequent support by the IAEA [10].

Projects and Activities Related to Radioactive Waste Management in Which the United Republic of Tanzania (URT) has Participated

The United Republic of Tanzania has participated in a number of IAEA supported projects since 1984 and also joined the IAEA Illicit Trafficking Data Base (ITDB) Programme in 2004. Some of the waste management projects in which URT has participated/participating are: “Strengthening Waste Management Infrastructure RAF/4/015; and “Sustaining the Waste Management Infrastructure RAF/3/005 which is a continuation of the Project RAF/4/015.

Other Projects which complements activities related to waste management and in which the URT is also participating includes “Establishment of National Capabilities to Radiological and Nuclear Emergencies, RAF/9/034”; and also “Strengthening the Capacity of AFRA Member States in Nuclear Security RAF/0/021”. Through these projects the URT has greatly benefited in terms of expert missions, fellowships, on job training courses including local and overseas and also various equipments that have been received.

Upcoming Programs on Waste Management

With the availability of the central storage facility (CRWMF), the government of the URT through the Tanzania Atomic Energy Commission is continuing effectively in solving the problems pertaining to the management of radioactive waste by removing disused sources from the public domain and also in strengthening the control on illicit trafficking of radioactive materials. In the near future, it is also planned to seek expert assistance to have the disused sources conditioned and stored in special “Long Term Storage Shields”. A pre-mission to this effect was conducted by IAEA recruited experts from 25-29 June 2007; and that the actual conditioning of the SHARS is planned for the second quarter of 2008. During this mission all the spent sources that are stored in the CRWMF, including other disused sources to be collected, will be conditioned and safely stored in the Facility.

A nation wide programme of search and secure will also be implemented to recover orphan sources if any and arrangements have also been made for TAEC to enter into agreement for the provision of disposal services with the institutions which are possessing radioactive sources but do not have the possibility of disposing of the sources.

CONCLUSION

It is to be noted that, the AFRA programs on radioactive waste management has brought about a very big impact on the attainment of a sound radioactive waste management regime in Tanzania. This has also been possible due to the full support received from the government of the United Republic of Tanzania

after having realized that the problem of radioactive waste would be a great hindrance towards the expansion and beneficial utilization of nuclear techniques for social economic development in the country.

The co-operation among AFRA Member states has been very rewarding in terms of experience and its commitment to address waste management problems in the region. It is therefore very important for African countries to intensify their co-operative activities in building the capacity and infrastructure for radioactive waste management so as to facilitate the safe utilization of nuclear techniques and in particular nuclear technology for electricity generation under the emerging nuclear power renaissance.

The government of URT highly appreciates and commends the IAEA for the provision of experts and support through the nuclear security fund in the development of the appropriate technologies such as the mobile hot cell for the handling of high activity sealed radioactive sources in the conditioning process. This technology could be an alternative option to the Borehole one.

The URT also highly appreciates the assistance provided by the United States of America, Department of Energy (US-DOE) and also the European Union through the IAEA nuclear security fund in enhancing the Radioactive waste management regime. That assistance has greatly enhanced security in nuclear/radiological installations and in particular the Central Storage facility in which disused sources are already been kept. The assistance which also involved trainings of the URT Customs, Police and other frontline officers has greatly improved the capability of the officers to detect nuclear and other radioactive materials at ports of entries and also in case of illicit trafficking of radioactive materials.

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