**CHALLENGES AND GOOD PRACTICES ASSOCIATED WITH ENSURING THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES THROUGHOUT THEIR LIFE CYCLE**

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**Abstract.**

Worldwide, radioactive sources are beneficially used in various fields such as in medical, agriculture, industry, research etc. However, these radioactive sources may present a potential health hazard to human (radiation exposure) if control measures are not put in place, especially those radiation sources that have relatively high activity. In order to avoid this health hazards, it is important to ensure that the safety and security of these radioactive sources are maintained throughout the life cycle of these materials. Since it is not easy to ensure the safety and security of radioactive sources, it needs a state commitment, knowledge, regulatory infrastructures, resources, national and regional cooperation, and technical capability. There are various challenges that are experienced during the life cycle management of radioactive sources. The lack of management policy for the radioactive materials is one of the challenges. Management and control of radioactive sources starts from the moment the source is produced until its disposal. This means the state/authority should have a policy in place to address how the source will be managed from the time the source is imported, until when is ready to be disposed (for the country with disposal option). The return to manufacturer is a good option to avoid accumulation of sources in the country especially in the absence of disposal option. However, it is still difficult to control the life cycle management of these radiation sources especially in the absence of regulatory framework. The laws and regulations are very important components in ensuring the safety and security of radiation sources. Some of the states have no regulatory body for radioactive material but others have the regulatory body but they have no regulatory framework in place. Some of the challenges facing the United Republic of Tanzania is the illicit trafficking which is contributed much by the other challenge of porous borders. The United Republic of Tanzania (URT) have several borders which are porous and this makes it difficult to control the movement of radiation sources even in the presence of the regulatory infrastructure. Another challenge is the discovery of unregistered sources in the country such as orphan sources that are out of regulatory control. Also, the lack of disposal option is another challenge because the accumulation of sources in the radioactive waste management facility does not only decrease the storage space, but also may increase the dose rates in the storage facility. Other challenges include the lack of information on country of origin for the sources intercepted during illicit trafficking. However, the country has put in place some good practices for managing radiation sources. These includes establishment of regulatory infrastructure, establishment of central radioactive waste management facility, return the sources to manufacturer and recognizing and participating in international cooperation to promote radiation safety and security.

1. INTRODUCTION

Radioactive sources are widely used worldwide in various beneficial applications. The field of applications ranges from medical, agriculture, industry, and various research areas [1]. Proper management and control of radiation sources is very important throughout of their life cycle (cradle to grave). This is because these radiation sources may cause potential health hazards such as deterministic effects to individual especially those radiation sources with a relatively high activity [2]. The safety and security of radiation sources is not only important for the facility owning the source but also for the public in general. The security of the radiation sources is needed because in the absence of control measures, they can fall into illicit trafficking leading to actions such as terrorists and other malicious acts that may jeopardize the public safety. Therefore, in order to avoid this health hazards that might be caused by the radiation sources, it is important to ensure that the safety and security of these radiation sources are maintained throughout the life cycle of these materials. It is the national responsibility to regulate the safety and security of radioactive sources.

However, radiation risk may cross the national borders and cause harmful consequences to another nation. Therefore, international cooperation is needed to exchange information and experience in order to promote and enhance safety and security worldwide [3]. It is not easy for one state to ensure the safety and security of radioactive sources/devices alone. Safe and secure management of radiation sources needs a country commitment, knowledge about radiation, regulatory infrastructures, resources, national and international cooperation, and technical capability. Tanzania is among the many users of radiation sources with various installation of which they may cause risk to the world community if they are not properly controlled. Figure 1 highlight the applications of radioactive sources in Tanzania.

*Fig.1. Applications of radiation sources in Tanzania (Source: Tanzania Atomic Energy Commission)*

1. CHALLENGES OF SAFETY AND SECURITY FOR LIFE MANAGEMENT OF RADIOACTIVE SOURCES

Globally, there are various challenges that are experienced during the life cycle of radioactive sources. Lack of the management policy for the radioactive materials is one of the challenges. Management and control of radioactive sources starts from the moment the source is produced until its disposal. This means the state/authority should have a policy in place to address how the source will be managed from the time the source is imported until when it is ready to be disposed (for the countries with the disposal option). The return to manufacturer is a good option to avoid accumulation of sources in the country especially in the absence of disposal option. However, it is still difficult to manage and control the life cycle management of these radiation sources especially in the absence of regulatory framework. The laws and regulations are very important components in ensuring the safety and security of radiation sources. Some of the states have no regulatory body for the control of radioactive material but others have the regulatory body but they have no regulatory framework in place.

Some of the challenges facing the United Republic of Tanzania includes the illicit trafficking. The motives for most of the illicit trafficking cases is still not known, could be intentional for malicious purposes, or unintentional for economic gain or sometimes lack of knowledge. This problem of illicit trafficking in the country is contributed much by another challenge which is the porous borders. The United Republic of Tanzania has extended porous border sharing with eight (8) countries which are Kenya, Uganda, Rwanda, Burundi, Democratic Republic of Congo, Malawi, Zambia, and Mozambique. Between each country, there are few official borders and the rest are unofficial borders that have no control. Like many African countries this porous border makes it difficult to control the movement of radiation sources even in the presence of the regulatory infrastructure. Another challenge is the lack of detection equipment at the borders and ports. Although the country has numerous borders and ports, not all of them has the portal monitors for the detection of radioactive materials. The absence of portal monitors can cause the entrance of undetected radioactive materials in the country which are out of regulatory control. Also, the discovery of unregistered sources such as orphan sources that are out of regulatory is another challenge because they are present in the country while their presence are not recognized by the regulatory authorities. The other challenge is the lack of information on country of origin for the sources intercepted during illicit trafficking. This is another radiation safety/security concern. Moreover, the lack of disposal option for the radioactive materials in the county is another challenge. Currently the United Republic of Tanzania has not yet decided the disposal option for the conditioned sources which brings the challenges in nuclear and radiological security. The accumulation of radiation sources in the Central Radioactive Waste Management Facility (storage) even with good storage infrastructure is also a problem because it reduce the storage space and cost for the monitoring systems. The facility after some time it will be full i.e. it will reach a time when it will no longer be able to accommodate that huge amount of sources. Also, the accumulation of a big number of sources in a single facility increases the security risk and dose rate in that facility.



*Fig.2. Tanzania map with bordering countries*

1. GOOD PRACTICES ASSOCIATED WITH ENSURING THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES THROUGHOUT THEIR LIFE CYCLE

The United Republic of Tanzania has established some good practices that aim to ensure the safe and security of radioactive sources. One of those good practices include the presence of regulatory infrastructure. With the regulatory body in place i.e. the Tanzania Atomic Energy Commission, the URT has promulgated the Law and the associated regulations to address the safety and security of radioactive sources both in-use and disused radioactive sources. The laws and regulations are very important components in ensuring the safety and security of radiation sources at any stage of the life cycle. The atomic energy matters in the URT is governed by: The Atomic Energy Act, number 7 of 2003 [4]. Also, there are three regulations that deal with radiation sources. These include Protection from Ionizing Radiation Regulations, 2004, Radioactive Waste Management for the Protection of Human Health and Environment Regulations, 1999, and The Packaging and Transport of Radioactive Materials [5]–[7]. In addition a regulation of security of radioactive materials are in the final stage to be approved by the government. Apart from establishment of regulatory framework, the URT has also established the system of managing the disused sealed radiation sources. In this case the country has established the Central Radioactive Waste Management Facility (CRWMF) to accommodate all the disused sealed radiation sources that are no longer applicable for its intended use and they have no obligations to be returned to the manufacturer. Moreover, the facility as well takes care of those sources that are found outside the regulatory control such as orphan sources. All of these sources once they found, they are collected and transported to the CRWMF for safe storage purposes. The central radioactive waste management facility acts as a long term storage (LTS) option since the country has no disposal option for the time being [6]. Another good practice that the country is doing to manage the radiation sources is to make sure that the radiation sources that are no longer fit for the intended applications, are returned to the manufacturer. This is achieved by the conditions stated in the regulation in which it becomes an obligation for the importer (licensee) to return to the manufacturer radiation source once it is declared being disused source. Figure 3 highlight the legal control of the radioactive materials.

* *Fig.3. Atomic Energy Act No.7 of 2003 and associated Regulations for the control or radiation sources in Tanzania*

Also, the URT recognize international cooperation as useful tool of ensuring safe and security of radiation sources by collaborating with international organizations such as the IAEA and its member states, US DOE and EU. Through these cooperation, the country has the opportunity to gain experience and information that can helps to detect and prevent any unauthorized movement of radioactive materials in and outside the county, and hence increase the levels of nuclear and radiation safety around the global.

1. CONCLUSION

The world has benefited economically and socially through the use of radiation sources in various legitimate applications. However, the beneficial use of radiation has a radiological concern to the human health and the environment. This is because of the increasing use of a number of radiation sources create challenges on the capacity on the management and control of radiation sources taking into consideration that today radioactive materials/sources are target for malicious use, their safety and security is of paramount. In view of this regulatory framework is needed to address the management throughout their life cycle. The United Republic of Tanzania has addresses some of these challenges including establishing of the law and associated regulations concerning the management of radioactive sources.

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