MANAGEMENT OF SPENT AND DISUSED RADIATION SOURCES- THE ZAMBIAN EXPERIENCE

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ABSTRACT

Zambia like all other countries in the world is faced with environmental problems brought about by a variety of human activities. In Zambia the major environmental issues as identified by Nation Environmental Action Plan (NEAP) of 1994 are water pollution, poor sanitation, land degradation, air pollution, poor waste management, misuse of chemicals, wildlife depletion and deforestation.

Zambian has been using a lot of radioactive materials in its various industries. The country has taken several projects with help of external partners. These partners however left these projects in the hands of the Zambians without developing their capacities to manage these radioactive sources. The Government recognised the need to manage these sources and passed legislation governing the management of radioactive materials.

The first act of Parliament on Radiation Protection work was passed in 1975 to legislate the use of ionising radiation. However, because of financial constraints the Country is facing, these regulations have remained unimplemented.
Fortunately the international Community has been working in partnership with the Zambian Government in the Management of Radioactive Material. Therefore this paper will present the following aspects of radioactive waste management in Zambia:

- Review Existing Legislation in Zambia regarding Management of Spent/Radioactive sources.
- Capacity building in the field of Management of Radioactive waste
- Management of spent and disused Radiation sources
- Existing disposal systems in Zambia regarding spent/orphaned sources
- Existing stocks of Radioactive sources in the Zambian Industries

REVIEW OF EXISTING LEGISLATION IN ZAMBIA

Ionising Radiation Act 1972

This regulates the handling, management and disposal of radioactive, and atomic waste.

However, considering the advances in technology, this Regulation is almost obsolete.

EPPCA and the Subsidiary Regulations Cap 204

The Environmental Protection and Pollution Control Act **(EPPCA)** of 1990 **PART IX** – Ionising Radiation seeks to achieve the following:

(a) Establish standards for the proper regulation of radioactive contamination;

(b) Inspected and examine any area, place or premises, or any vehicle, vessels, boat, aircraft or any carriage of any description in or upon which the Inspectorate has reasonable cause to believe that radioactive material or any source of ionising radiation is stored, used, transported or disposed of;

(c) Examine any person with respect to matters under this Part, where there is reasonable cause to believe that that person is contaminated with radioactive material or is unlawfully in possession of an ionising radiation source;

(d) Provide information, warn and protect the public, in case of actual or potential public exposure to radioactive materials or ionising radiation in the environment;

(e) Liase with the Radiation Protection Board established by section five of the Ionising Radiation Act, the Prescribed Minerals and Materials Commission established by section five of the Prescribed Minerals and Materials Commission Act, or any other organisation dealing with radioactive material;

(f) Conduct an ionising radiation monitoring programme and advice on ionising radiation control and protection measures;

(q) Maintain records of releases of radioactive contaminants into the environment and keep records of natural background levels of radiation in the environment;

(h) Request any outside authority to offer assistance required to help carry out the duties of the Inspectorate; and

(i) Do all such things as appear to be necessary for the monitoring and control of pollution from radiation.

CAPACITY BUILDING IN THE FIELD OF MANAGEMENT OF RADIOACTIVE WASTE

The ever-increasing demand for maintaining a healthy environment requires specialised teams of experts to manage waste. The management of radioactive wastes has been placed under two statutory government institutions, namely **Radiation Protection Board** (RPB) and the Environmental Council of Zambia **(ECZ)**.

- **ECZ Roles and Responsibilities**

The ECZ plays advisory, regulatory, consultative, co-ordination and international roles on all environmental issues in Zambia. Its main objective is ***to provide for a clean and healthy environment for all (persons, animals and plants) by working with individuals, committees, and private and public institutions, governmental and non-governmental organizations in the management of the environment.***

- **ECZ undertakes the following specific responsibilities.**

- Advise on all matters relating to any environmental conservation, protection and pollution control, including necessary policies, research, investigations and training.
- Conduct studies and make recommendations on the standards relating to the improvement of the environment and the maintenance of sound ecological system.
- Undertake environmental education programmes for the purpose of creating an enlightened public opinion regarding the environment, and the public of their role in the protection of and improvement of the environment.
- Identify projects, plans and policies that need Environmental Impact Assessments, and reviews environmental assessments documents.
- Monitor trends in the use of natural resources and their impact on the environment.

- **Radiation Protection Board (RPB)-Roles and Responsibilities**

RPB is mandated to carry out the following roles:

- Determine the extent and risk of exposure to ionising radiation to workers and the general public
- Ensure the safe, handling, storage and disposal of radioactive materials and waste in the country.
- Licence and inspect all radiation sources and facilities in the country and ensure that set conditions are adhered to.
- Provide a national register of workers handling any radiation materials and determine the amount of radiation doses received by these workers. The RPB also maintains a register of radioactive waste materials.

Despite the existence of these regulatory bodies, a lot needs to be done because the two bodies do not capacity to handle radiation related problems in the country.

The major problems facing these two institutions are:

- Inadequate financial support from the government
- Lack of trained manpower**- only three officers at RPB**.
- Inadequate research and development to support radioactive waste management activities.
- Absence of radioactive waste inventories.
- Lack of regulations/guidelines and strategies on waste management.

MANAGEMENT OF SPENT AND DISUSED RADIATION SOURCES

Several African Countries have recognised the need to have effective institutions to manage all kinds radioactive material. In view of the above, several African States have come together to form AFRA (Africa Regional Co-operative Agreement for Research, Development and Training related to Nuclear Science and Technology). These African Countries approached the International Atomic Energy Agency (**IAEA**) so that IAEA can help to establish a regional arrangement for Co-operation in the field of nuclear Science and technology in Africa.
The aim of this grouping is to promote the development and application of nuclear science and technology in Africa. Zambia became a member of AFRA on December 20th 1993.

After realising that Zambia was lagging behind in the management of Nuclear Waste, the country set out the following objectives in this regards:

i. Develop and implement a waste management regulation/guidelines
ii. Collect, condition and store all spent source with the help of AFRA specialised teams.
iii. Manage the spent sealed sources
iv. Identify and assess the hazards associated with naturally occurring radionuclides.
v. Manage lowlevel radioactive waste from medical application.

To achieve the above objectives, the following expected outputs targeted:

i. Immobilization of spent radioactive sources
ii. Collection, conditioning and safe storage of radium sources
iii. Safeguarding the population and the Environment and eliminating undesirable transboundary movements of radioactive wastes for illicit dumping.
iv. Train personnel in radioactive waste management
v. Establish a radioactive waste management system in the country.
vi. Quantify the hazards and formulate the action plan arising from naturally occurring radionuclides.

Against such a background the following have been some activities undertaken to date:

- **Immobilization of spent radioactive sources**

The IAEA supplied to Zambia Nal Detector SD 20 x 20 coupled to the prospector and OxfordWin -MCA running Windows 95 operating system. With this equipment the country was able to identify 21-shielded containers as being radioactive waste. Therefore the need to immobilize these has arisen. The Country carried out an inventory of the existing stocks of radioactive waste **Table I** shows some of the wastes is stocked in Zambia.

Table I : Existing Radioactive Sources not Immobilised in the Copper Mining Industry**.**

NO. OF SOURCE	SOURCE DESCRIPTION	MEASURED SURFACE DOSE (Usv/h)	Detector to source (cm)	Energy (Kev)	Counts/s	Source Identification
1H001	Model: B400-001 Serial: 2011G6 100mCi Cs-137	28.5	25.0	661.6	508	Cs-137
1H002	Isotope No 27	36.6	25.0	661.6	330.0	Cs-137
1H003	R/Co 43042	0.12	0.5	661.6	4.5	Cs-137
1H004	None	5.1	25.0	661.6	56.6	Cs-137
1H005	None	5.72	25.0	661.6	52.6	Cs-137
1H006	None	5.82	25.0	661.6	68.7	Cs-137
1H007	Phillips T10-288	17.2	15.0	24.88 57.8	1647.1	Am-241
1H008	Phillips T10-288	7.51	25.0	24.88 57.8	634.9	Am-241
1H009	Phillips T10-288	8.41	25.0	24.88 57.8	960.6	Am-241
1H010	Model: BW30 Source: Am241 Activity: 100mCi Date: 10/1975	61.0	75.0	30.2 57.5	8191.3	Am-241
1H011	Au Type PM218Y00 NR 602399 Phillips	0.22	5.0	661.6	4.31	Cs-137
1H012	394 5mCi Ra	10.5	10.0	607	7.26	Ra-226
1H013	Threaded bolt pig tail	0.15	5.0	661.7	3.91	Cs-137
1H014	None	147.0	75.0	607.0	17.50	Ra-226
1H015	Ra-226	112.0	75.0	607.0	32.7	Ra-226
1H016	Ra-226	2500.0	75.0	807.0	1141.7	Ra-226
1H017	None	1700.0	100.0	661.6	766.84	Cs-137
1H018	Y269	22.0	5.0	None	-	Unknown
1H019	Co-60:80	22.0	5.0	None	-	Unknown
1H020	None	12.0	25.0	661.6	196.5	Cs-137
1H021	None	?	25.0	1173+ 1332	13.15	Co-60
1H022	None	1.670	5.0	661.6	232.3	Cs-137
1H023	Co-60 (30mCi)	0.12	10	1175+ 1332	1107.68	Co-60

In addition to the above wastes, other sources from other industries in the country are stored at the National Institute for Science and Industrial Research (NISIR) in Lusaka. The existing stocks at NISIR are shown in table II below

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Table II- Typical List of other radioactive Waste in the Country

Name of Radioisotope	Activity in Ci	Date of Manufacture	Supplier	Purpose	Condition	Storage facility
Gamma source				Calibration	Good	Box
Co-60	5uCi			Calibration	Good	Lead case
Mixed Std soln		1/10/1989	IAEA	Calibration	Good	Plastic Container
Uranyl				Std	Good	Bottle
H-3	5.4uCi	1/10/1984	Armesham UK	Std	Good	
Cs-137 std soln	108mCi	1/08/1986	Same as above	Std	Good	Bottle + Tin
Sr-90 Std soln	54mCi	1/07/1984	Same as above	Std	Good	Bottle +Tin
2 Std soln	108mCi	1/09/1985	Same as above	Std	Good	Bottle + Tin
Uninyl				Std	Good	Two bottles
Thorium nitrate Hydrate	0.0467uCi/g			Std	Good	Bottle

In addition to the above an extra 40 sources are kept at NISIR.

- **Existing Disposal Systems in Zambia**

The Country has been using radioactive materials for over 100 years now. However, no proper disposal system existed up to 1990 when immobilization of sources commenced. Before that time, various institutions that were using radioactive materials used to burry these.
The danger associated with burying these wastes was obvious. Therefore in 1990, Zambia undertook an exercise of exhuming these buried wastes.

A large quantity of radioactive waste was identified in the northern part of the Country as well as in the Capital City, Lusaka itself. However, the **Radiation Protection Board** (RPB), the Country's regulatory authority in nuclear waste management has no resources to immobilize and move these wastes to a safe storage area
Further the country now keeps all radioactive wastes in a special building isolated away from human habitation. Some weak sources have been placed in

concrete lined drums if the radiation from such sources can be contained in such a manner.
Zambia seems to be lagging behind in the use of nuclear materials. For example the country is still using a lot of radioactive materials with long half-lives.
The country as at present does not have a disposal system for radiation waste. The current practice of 'disposal' is by immobilization of the radioactive sources and keeping these at a designated site. Tables III –VI shows some of the materials that has been immobilized and kept at various sites.

Table III Immobilized Cs –137 Sources in the Zambian Copper Mines

Mine Site	Activity																			Total
	2	3	5	20	35	50	100	128	150	200	250	300	500	750	1000	2000	3000	5.5 GBq	Unknown	58
Nchanga	0	0	0	3	1	7	5	0	5	1	0	4	6	4	5	1	9	0	7	58
Mufulira	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	9
Chambishi	0	2	6	0	0	0	3	0	0	70	6	0	3	0	5	0	0	0	2	34
Konkola	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Nkana	4	1	1	0	15	7	3	1	3	0	0	1	1	0	0	0	0	0	5	42
Luanhya	0	0	0	0	1	0	1	0	0	8	0	0	3	0	0	0	0	1	0	14
Total	4	3	7	5	17	17	12	1	8	16	6	5	22	4	10	1	9	1	14	162

- **Develop and implement a Radioactive waste management regulation**

The lack of legislation on radioactive waste continues to be an obstacle to the development of an effective radioactive waste management system. The draft radioactive waste management regulations were compiled a long time ago but are yet to be enacted into law. These regulations are like to be obsolete by the time they are enacted because of the dynamics that may have taken place in the Management of Radioactive waste.

- **Environmental /Health Effects of Radiation ionisation in**

Statistics at the **Radiation Protection Board** (RPB) shows that there are 130 institutions in Zambia dealing in radioactive waste. A total number of 980 radiation workers are therefore exposed to radiation. The RPB monitors the amount of exposure to radiation by these workers.
A preliminary survey undertaken in 1998 in the mines shows that **40%** of the surveyed mine had a mean radon levels above the action level of **1000Bq/m^3**, that is **6mSv/year** recommended by the IAEA.

CURRENT STATUS OF RADIOACTIVE WASTES.

The table below shows the summary of what the country has achieved as far as management of spent sources is concerned.

Table IV – Summary of the condition of radioactive sources in Zambia

Location	Spent/Decommissioned sources in Storage	Spent/Decommissioned sources - Conditioned	Spent sources at RSS	Sources awaiting conditioning	Total number of drums/caskets for storage at RSS
Mufulira	16	15	0	1	15
Nkana	17	58	58	10	22
Chambishi	10	34	34	10	22
Luanshya	1	14	0	1	9
Konkola	1	5	5	1	3
Nchanga	0	73	73	0	72
Ndola Lime	1	0	0	1	1
Analytical Services	0	0	0	1	0
Total	**14**	**199**	**170**	**33**	**165**

From the table above it can clearly be seem that the Country seem have done very little in both legislation and management of radioactive waste. Further there is need to strengthen corroboration with professional bodies like the IAEA so that the country can benefit from its expertise.

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