

THE CURRENT STATUS OF NORM INDUSTRIES IN ZIMBABWE AND SUGGESTION OF REGULATORY FRAMEWORK.

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1. Introduction

The Earth's crust contains various types of elements trapped within it since its formation such as Uranium and Thorium with radioactive isotopes like Uranium-237 (²³⁷U), Uranium-238 (²³⁸U), Thoron-232 (²³²Th). Uranium-238 decays to form Radium-226 (²²⁶Ra) which also decays to give Radon-222 (²²²Rn). Materials that contain radioactive elements that are found naturally in the environment are called Naturally Occurring Radioactive Materials (NORM).

NORM is essentially found in varying quantities depending on the geology, in all soils, bodies of water, minerals and ores that humans might be exposed to such as iron ore, phosphate rocks, coal, bauxite, tin, gold, copper, tantalum and rare earth metals.

NORM is radiation from radioactive elements that are found in the earth and rocks. According to The National Academy of Science (1987), most of the radiation exposure in the environment comes directly from NORM [1]. However, some human activities may increase the amount of radiation from NORM. Mining, industrial processing, road, and building infrastructure construction are some of the human activities that increase radiation exposure from NORM. For instance, Radon gas, which is responsible for almost half of the dose from terrestrial radiation, is normally trapped underneath the Earth. But this gas can be freed up if the earth is excavated through mining or building a subway, thus, the activity of man related to advancement in technology has a direct impact on the levels of NORM. This particular type of NORM is called Technologically Enhanced Naturally Occurring Radioactive Material (TENORM). Industries where TENORM is found metal ore processing, Uranium mining, fossil fuels, oil and gas extraction, titanium pigment production. human beings and animals are exposed to radiation from Naturally Occurring Radioactive Materials (NORM). The amount of radiation dose that was set for the public is 1milliSievert (mSv) per year [2]. This level of radiation dose is considered safe for human beings.

2. Materials and Methodology

2.1 NORM INDUSTRIES

According to the International Atomic Energy Agency (IAEA) reports [1], the principle NORM industries are distributed as follows:

- (1) Extraction of rare earth elements;
- (2) Production and use of thorium and its compounds;
- (3) Production of niobium and ferro-niobium;
- (4) Mining of ores other than uranium ore;
- (5) Production of oil and gas;
- (6) Manufacture of titanium dioxide pigments;
- (7) The phosphate industry;
- (8) The zircon and zirconia industries;
- (9) Production of tin, copper, aluminum, iron and steel, zinc and lead;
- (10) Combustion of coal;
- (11) Water treatment.

The most important radionuclides in the scheme of radiation protection are ²³⁸U, ²³²Th and ⁴⁰K.

Table I: Properties of radionuclides in the Uranium decay series [3]

Isotope	Half-life	Decay	Organs Affected
²³⁸ U	4.5 x 10 ⁹ yr	Alpha	Lungs, kidneys
²³⁴ Th	24d	Beta	Lung, skeleton, colon
²³⁴ Pa	6.8hr	Beta	
²³⁴ U	2.4 x 10 ⁵ yr	Alpha	Lung, kidney
²³⁰ Th	7.3 x 10 ³ yr	Alpha	Lung, skeleton, liver, colon
²²⁶ Ra	1.6 x 10 ³ yr	Alpha	Lung, bone
²²² Rn	3.8d	Alpha	Lung
²¹⁸ Po	3.1min	Alpha	Liver
²¹⁴ Pb	27min	Beta	Bone

²¹⁴ Bi	20min	Beta	
²¹⁴ Po	160μs	Alpha	Liver
²¹⁰ Pb	22yr	Beta	Bone
²¹⁰ Bi	5d	Beta	
²¹⁰ Po	138d	Alpha	Liver
²⁰⁶ Pb	stable		

Table 2: Properties of radionuclides in the Thorium decay series

Isotope	Half-life	Decay	Organs Affected
²³² Th	1.4 x 10 ¹⁰	Alpha	lung, skeleton, liver, colon
²²⁸ Ra	5.75 years	Beta	Lung, bone
²²⁸ Ac	6.15 h	Beta	
²²⁸ Th	1.9116yr	Alpha	lung, skeleton, liver, colon
²²⁴ Ra	3.66 d	Alpha	Bone, lung
²²⁰ Rn	55.6 s	Alpha	Lung
²¹⁶ Po	0.15s	Alpha	Liver
²¹² Pb	11h	Beta	bone
²¹² Bi	61min	Beta	
²¹² PO	0.30 μs	Alpha	Liver
²⁰⁸ Pb	stable		

2.2 Regulation of NORM

The regulatory body in Zimbabwe responsible for NORM is the Radiation Protection Authority of Zimbabwe (RPAZ). The organization was formed in 2009 according to the provisions of the Radiation Protection Act of 2004. The regulatory framework of NORM currently entails; exemption, notification registration and licensing. The main criteria of NORM regulation involve monitoring NORM levels in industries related to NORM in order to establish

radiation exposure levels to workers handling NORM, by-products or processed products and investigating radionuclide concentrations in consumer products intentionally or inadvertently used with NORM in order to ensure the public is not exposed to unacceptable radiation.

2.3 NORM Industries in Zimbabwe.

Zimbabwe has a very large mining sector which includes the mining and processing of platinum, nickel, copper, gold, tin, coal, aluminum, zinc, lithium, gold etc., and other NORM producing industries like coal combustion and phosphate production.

2.4 Graded approach

For a system of control, such as a regulatory system or a safety system, a process or method in which the stringency of the control measures and conditions to be applied is commensurate, to the extent practicable, with the likelihood and possible consequences of, and the level of risk associated with, a loss of control.” To develop a graded approach requires (i) control measures that can be applied at various levels of stringency, and (ii) a means for assessing the risks associated with the loss of control”.

3. Conclusions

In the country of Zimbabwe, the NORM industry is vast and varies widely. The most effective approach to NORM regulation in Zimbabwe is implementing the principle of graded approach.

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