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Study of the Prevention of the Risks of Contamination and External Exposure of Persons Working in Mineral Crafts (Case of Musompo Site)

Robert LWAMBA ILONDA, Patrick MBWEB KATSHIL *, John MWENGE KAHINDA and Tony KAYIJ KANZ NTET
Commissariat General for Atomic Energy, Ministry of Scientific Research - Lubumbashi, Democratic Republic of Congo
*Corresponding author email id: patrickkat2013@gmail.com

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***Abstract* – Today, the problems of contamination and external exposure from radioactive materials have become less frequent and mastered in various African countries. Following mining activities located in areas rich in desired metals, which generate large amounts of solid, liquid and gas in the environment. We note that the protection of the environment and workers against ionizing radiation seems to be overlooked in favor of employers, seeking to monetize the production of desired products (Cu, Co, Zn, Ag ... etc) without referring to natural radionuclides that can be found at the mine site which emit ionizing radiation, protection of workers against radiation in their providing adequate equipment and also without taking the necessary precautions to protect the environment against these.**

Indeed, to get an idea on the prevention of risks from contamination and external exposure, we decided as a research technique based on the interview and questioning of all the hard working people without holding individual protection and holding protection.

***Keywords* – Artisans, Exposure, Mining, Prevention, Risk.**

I. INTRODUCTION

As a result of artisanal mining activities in the town of Kolwezi, located in the Lualaba province of the Democratic Republic of Congo, we note that artisanal miners are not interested in the risks of contamination and external exposure to which they are stopped, But rather seek to make profitable their productions mining products extracted and sold, containing metals including copper and cobalt.

The protection of workers against the ionizing radiations is not taken into account by the latter in their equipping with the adequate equipment for their protection; out of the radioactive materials can contaminate people by inhalation, ingestion or contact, from their physicochemical form (Delacroix, Guerre, & Leblanc, 2006).

Once incorporated, some of this contamination will be eliminated by the body. The remainder will be attached to target organs (NRPB-R245, 1991) and (D. -J. Gambini & Boisserie, 2006)

The emission of radiation will continue and the damage to the cells due to this internal exposure will appear.

The problem of prevention consists in avoiding this contamination or in limiting it, by the techniques of confinement of materials and remediation of the places of work (Euratom, 2013). It is also possible to act on the source term by adapting the choice and quantity of radioactive material to the strictrequirement of the process.

It is a problem whose conceptual model is that of chemi--cal risk (ABBASSI, mars 2014).

However, the risk assessment does not involve ppm, but the evaluation of the energy deposited by ionization on the tissues after contamination; Submit staff to an external exhibition (Archambaultl, G. Leroy, & Prugnaud, 2005).

The problem of prevention is then usefully comparable to that of the risk "acoustic noise", since the conceptual model of prevention can be summarized in three words: screen, distance, time (EC_Radiation_Protection, 2004). The action on the source term must be considered in the same way as above. Of course, the risk assessment must make it possible to characterize all the components of the radiation and the implementation of the screens must take into account all the radiations that result from this characterization (Servent, Gauron, & Boulay, fevrier 2005).

Indeed, the mining boom in Katanga contributes significantly to the effects of ionizing radiation on the environment and on the population that is affected by low doses of radioactivity emitted by mining products such as Cobalt, Copper, Tin and others.

Radiological protection of the environment is based on the recommendations of the International Commission on Radiological Protection (CIPR, 2007), which today professes that the measures taken to protect man from radiation provide adequate protection To other species because humans live in the same environment and eat food from them (AEN, 2006).

The Objective of Our Study is to:

- Make people working in the mining industry aware that they are at risk of contamination and external exposure when working without putting personal protective equipment (PPE) in place. D. Delacroix, J. -P. Guerr and P. Leblanc towards the year 2006.
- And propose a good working system to avoid contracting diseases caused by ionizing radiation while respecting the following fundamental principles published by the ICRP 103 of 2007 as well as by: justification, optimization and limitation of doses individual.

The tables below give us the dose limits for classifying radioprotection areas as recommended by ICRP 103 for 2007.

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Table 1. Subdivision of zones according to dose rates.

TYPE OF THE ZONES	EFFECTIVE DOSE (E)	DOSE EQUIVALENT RATE (H')	DOSE EQUIVALENT (He)
ROOM CONTIGUOUS TO SURPERVISED AND CONTROLED AREA	<80µSv /month	-	-
CLEAN AREA	<7,5µSv/ 1h	-	<0,2mSv/ 1h
GREEN AREA CONTROLLED	7, 5 <E<25 µSv/ 1h	-	0,2<He<0,65m Sv /1h
YELLOW AREA CONTROLLED	<2mSv/1h	<2mSv/h	<50mSv/ 1h
ORANGE AREA CONTROLLED	<100mSv/1h	<100mSv/h	<2,5 Sv /1h
RED AREA CONTROLED	> or = 100mSv/1h	> or = 100mSv/h	> or 2,5 Sv/ 1h

E: Effective dose;
He: Dose equivalent ends (hands, forearms, feet, ankles);
H ': Maximum dose equivalent rate.

Table 2. Classification of workers according to the annual doses absorbed.
The table below gives the annual exposure limit values over 12 consecutive months.

	WHOLE BODY	CRYSTALLINE	SKIN
CategoryA	20 mSv/Year	150 mSv/Year	500 mSv/Year
CategoryB	6 mSv/Year	45 mSv/Year	150 mSv/Year
Public	1 mSv/Year	15 mSv/Year	50 mSv/Year

II. Work Methodology

The work consists of identifying, on the basis of the interview and an established questionnaire, all representatives of deposits and their respective deposits, as well as the number of workers who will be the subject of our study of prevention of contamination risks and external exposure related to the artisanal mining activities that are carried out on this site. And without forgetting the presentation of the results of the studies of radioactivity evaluations carried out on this trading site.

This technique will allow us to have an idea of the number of workers protected or unprotected against the dangers of ionizing radiation and convert these results into statistical data.

III. Presentation of Results and Discussion

A. Presentation of the Results

Table 3 below shows the managers of various mining deposits and their agents found at work on the Musompo site during our descent; and shows how they work with or without personal protective equipment (PPE).

It should also be noted that deposits with a rate of more than 50% do not mean that they are working under the right conditions.

To fully understand this aspect; we shall say that; these workers only put on the following personal protective equipment: clothing, masks, glasses, boots, gloves, etc.

B. Figure I: see below

C. Figure II: Presentation of Deposits According to the Workers.

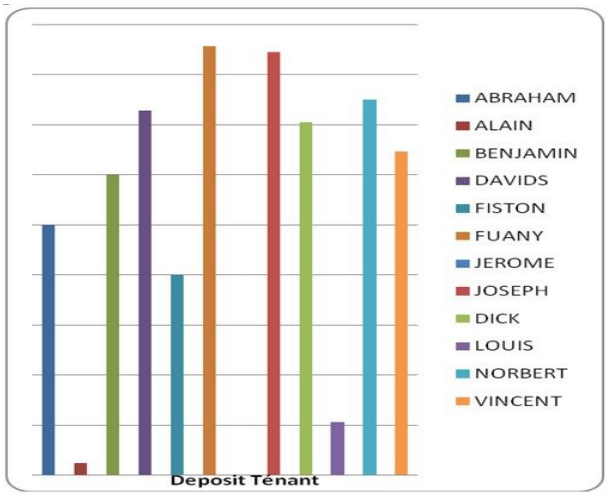

Table 3. Assessment of agents working in different mining deposits with or without personal protective equipment (PPE).

N°	TENANTS OF THE MINING DEPOSITS	DEPOSIT NUMBER	AGENT/ DEPOSIT NUMBER	WEAR PPE	PROTECTED WORKERS PERCENTAGE (%) WEAR PPE	NOT PROTECTED WORKERS PERCENTAGE (%) WEAR PPE	RADIOACTIVE VALUES AVERAGE (µSv/h)	HEALTHINESS EVALUATION OF THE DEPOSITS
1	ABRAHAM	1	8	4	50	50	0,12 - 0, 65	Food selling, and beverage , pregnant, and children
2	ALAIN	4	43	1	2,33	97,67	0,55 - 1, 84	IDEM
3	BENJAMIN	2	15	9	60	40	0,47 - 2,27	IDEM
4	DAVIDS	5	48	35	72,9	27,1	0,27 - 1,27	IDEM
5	FISTON	1	10	4	40	60	0,33 - 0, 48	IDEM
6	FUANY	3	21	18	85,7	14,3	0,24 - 0, 68	IDEM
7	JEROME	4	34	0	0	100	0,37 - 0, 84	IDEM
8	JOSEPH	2	13	11	84,6	15,4	0,43 - 0, 98	IDEM
9	DICK	2	17	12	70,6	29,4	0,27 - 0, 96	IDEM
10	LOUIS	18	181	19	10,5	89,5	0,27 - 0, 70	IDEM

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N°	TENANTS OF THE MINING DEPOSITS	DEPOSIT NUMBER	AGENT/ DEPOSIT NUMBER	WEAR PPE	PROTECTED WORKERS PERCENTAGE (%) WEAR PPE	NOT PROTECTED WORKERS PERCENTAGE (%) WEAR PPE	RADIOACTIVE VALUES AVERAGE (µSv/h)	HEALTHINESS EVALUATION OF THE DEPOSITS
11	NORBERT	1	8	6	75	25	0,13 - 1,46	IDEM
12	VINCENT	8	68	44	64,7	35,3	0,25 - 0, 95	IDEM

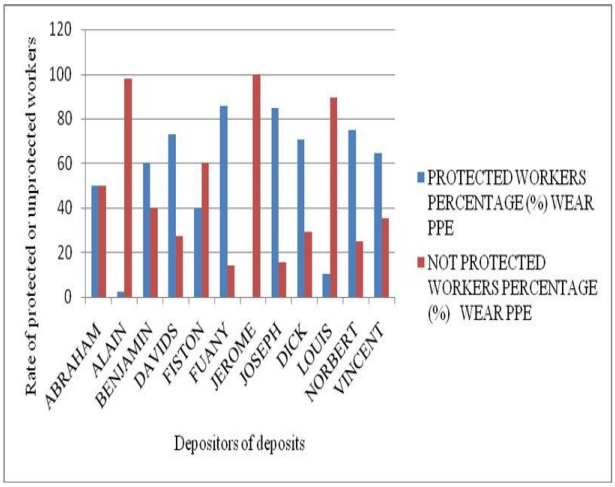

Fig. I. Presentation of deposits according to the rate of persons (workers) working with or without individual protection.

IV. Interpretation and Discussion

Use Tables 3; also give us the different values of the radioactivity levels measured at the contact on different batches of the ores stored in different mining deposits after taking the values of the background noise. And we note that almost all mining deposits exceed 0.5 µSv/h (i.e. 1 mSv), which is the public value of the measurements taken on batches of stored mineral products, although the measured values are acceptable. And there is the possibility of increasing the concentration of radioactive element on the ground by daily storage of the mining products; and the risk of contamination and external exposure will be very likely when public hygiene and health conditions are not implemented.

And to see whether sanitary conditions are met or not, the same table 3 gives us an overview of how workers are treated on-site with regard to protection against the danger of ionizing radiation:

Table 3 above shows that 3 out of 12 deposits do not provide personal protective equipment for protection against the danger of ionizing radiation and in such cases there is a likelihood of Contamination and external exposure;

Taking just one case in the table above; The LOUIS Tenancier, which has about 181 agents for 18 depots, we note that 19 people put personal protective equipment at a rate of 10.5% which is very low;

The 9 others make EPIs available to their agents, but since they are not used to working with equipment, they put it aside;

As noted in the table above, having 70% or 80% of the wearing of PPE on them, does not mean that they comply with the radio protective instructions or they put the PPEs to full extent;

In all mining depots, we found sellers and sellers of different foods that were exposed to the ground;

The measured radioactivity values are acceptable but may be responsible for radiation-induced cancer among workers, if we refer to the phenomena caused by the stochastic effects;

Referring to the international standards on the classification of radiological zoning of work sites, published in 2007 by ICRP 103 (International Commission on Radiological Protection), we will say that these workers are classified in category B; and requires regular follow-up like, they are every day on the job site without rest.

V. Results

The work that was the subject of our study allowed us to know the problems that the workers of different mining deposits are facing compared to the notion of prevention of the risks of contamination and external exposure during the activities carried out on the MUSOMPO site to know:

- Crushing and manual grinding carried out without EPIs;
- Screening and drying of products without EPIs;
- Back-up mining products without EPIs during loading and unloading operations in almost all depots; Only the Chinese, the accountant or cashier and the head of deposit heading the work put a nose cache, both the gloves and the outfit. This is what enabled us to say in the interpretations of the results that having a rate of more than 50% of people who put on PPE does not mean that they work under the right conditions;

VI. Conclusion

To conclude, we suggest the following to ensure that the risks from external exposure are kept as low as possible and enforced by instilling in workers the right ways to work with PPE in a clean environment to avoid all forms of contamination related to this activity:

- Place geo-membranes in all deposits to avoid aerosol inhalation during labor;
- Install a simplified wastewater treatment unit on this site;
- Work with PPE;
- Do not leave pregnant women and children in mining depots;
- Do not eat, smoke, drink and sell in the repository to avoid taking radioelements into the human body by ingestion;
- Avoid bringing clothes to work at home to avoid bringing the radioactive micro particles attached to

the clothing to the city because there is a risk of contaminating the others;

- Build showers to wash before going home;
- To regularly sensitize artisanal mining operators on the appropriateness of wearing PPE and diseases caused by ionizing radiation in general (Ex: radiation-induced cancer ... etc);
- Regarding the exposure of personnel: there is a lack of medical follow-up to radioactive exposure. Personnel are considered to be working under radiation and are in Category B and must not exceed a radioactivity value of 1 mSv/year due to 2000 hours / year of work; Thus, we may consider as a matter of concern the exposure of personnel working permanently without EPIs near these mining products; Published by the Radionuclide and Radiation Protection Practical Guides, Vol. 39, 2 eme Edition in the years 2006.
- A dosimetric monitoring program of workers will be possible on this site with these results obtained. But the monitoring and continuous monitoring of the workstations and the environment of the latter must be subject to periodic planning in order to avoid any contamination and exposure of workers.

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AUTHORS' PROFILES

LWAMBA ILONDA Robert,
Chemist, University Campus of Kinshasa a the Faculty of Science, Principal coordinator of the activities of the Antenna of the/ Katanga In the control of the radioactivity, the harvest of the samples for analysis and the emission of the certificates General Office of Atomic Energy / D.R CONGO. Kavumu The 02 February 1053

MBWEB KATSHIL Patrick,
Bachelor (Hons) degree in Chemistry from the University of Lubumbashi (Democratic Republic of the Congo) in 2008. He is currently a research assistant to the General Office of Atomic Energy/ DR CONGO. Since 2008, he gives lectures and seminars in chemistry at public university in D.R. Congo.
Specialist in Radiation Protection and Safety of Ionizing Radiation Sources formed by the Mohamedia School of Engineer and the National Center for Energy, Science and Technology CNESTN, Morocco.

MWENGE KAHINDAJohn,
The 01 January 1975 Pharmacist, University of Lubumbashi/ RDCongo 2005 at the Pharmaceutical Faculty of Science Researcher with the General Office of Atomic Energy/ DR CONGO, controls radioactivity of the exploitation to export, Mining products in the mining companies and deposit and of the environment.

KAYIJ KANZ-NTET Tony,
Bachelor (Hons) degree in Chemistry from the University of Lubumbashi (Democratic Republic of the Congo) in 2016. He is currently a research assistant to the General Office of Atomic Energy / D.R CONGO.