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Prevention and Management of Risks Related to Radiological and Nuclear Materials under International Nuclear Law: Case Study of the Democratic Republic of Congo

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Abstract

We conducted this research on the prevention and management of risks related to radiological and nuclear materials within the framework of international nuclear law, using the Democratic Republic of Congo (DRC) as a case study. This was based on the observation that in the DRC, the protection of the Congolese population and the environment against the effects of ionizing radiation is marked by certain shortcomings, despite the mechanisms put in place. From the outset of our research, we assumed that this situation is due to the non-compliance of national legal texts with international nuclear safety and security requirements. Precautions must therefore be taken. Dangers in the use of nuclear energy can result from the mishandling of nuclear and radiological materials, illicit trafficking and their use for criminal purposes. To this end, international nuclear law attaches particular importance to the protection of people and the environment against the dangers of nuclear and radiological materials. This justifies the diversity of the norms and the search for consistency in their revision, the objective being to ensure the best possible protection of the population and the environment. The DRC can greatly benefit from these international standards to strengthen its statutory and institutional framework for the protection of the population and the environment against the dangers of ionizing radiation. Thus, our study examines and questions the Congolese legal system, to find its weaknesses and propose the amendments best suited to the requirements of international law, in view of the contemporary issues at stake in the Democratic Republic of Congo and in

the world. The importance of this study lies not only in understanding the international mechanisms for the protection of the population and the environment against the risks of radiation, but also in the need and urgency to guarantee better protection of the population and the environment through better regulation in the Democratic Republic of Congo.

Keywords

Risks Prevention and Management, Nuclear and Radiological Materials, Nuclear Security and Nuclear Safety, Democratic Republic of Congo

1. Introduction

Among the major causes of recurrent national and international armed conflicts in the DRC is the infatuation of multinational lobbies and certain states with the riches of the Congolese soil and subsoil, even at the cost of hundreds of thousands of innocent Congolese lives. At the same time, in the absence of adequate nuclear safety and security regulations, the illicit exploitation and trafficking of radiological and nuclear materials (through the looting of minerals, the detour of radiological sources, the poor maintenance of nuclear reactors, etc.) are also the major cause of exposure to very high risks of radiation, contamination, epidemics, pollution, fire or explosion, poisoning, and other problems. Unfortunately, most of the perpetrators of all these crimes have not, until now, been arrested or brought to justice.

However, it was since the end of World War II, just after the creation of the United Nations, that all nations of the world had expressed their revulsion at the bombing of two Japanese cities by nuclear weapons, which led to the rapid creation of the Commission to examine the question of nuclear use in depth at the first meeting of the General Assembly in January 1946. Similarly, several campaigns by scientists had led to the proposal to establish an international authority with the power to control, inspect and license nuclear activities in all their aspects, as envisaged in the Acheson-Lilienthal report. This report also made concrete proposals, such as stopping the production of atomic bombs and eliminating existing bombs by treaty (Rotblat, 2003a). This is how the International Atomic Energy Agency was later created in 1957.

As Norbert Pelzer points out, the exploitation of nuclear materials can present many environmental risks. And the DRC cannot be an exception to this; on the contrary, it must equip itself sufficiently to deal with them (Pelzer, 2010). Indeed, the international imperatives of nuclear safety and security (Johan Rautenbach and Wolfram Tonhauser, 2006), the need to preserve renewable or non-renewable natural resources and Congolese biodiversity (including forest reserves of water, flora, fauna and minerals), the risks of a nuclear war that still threatens to devastate the entire planet, etc... are all challenges that place the Congolese government in a difficult position between its international obligations and the vital in-

terests of its population mostly peasant and poor.

This state of affairs raises a number of questions about the nuclear safety and security mechanisms that exist or should be put in place to best protect civilian populations from the risks associated with radiological and nuclear materials, including on one hand the legal and institutional measures that are in place or should be put in place to protect not only the Congolese people, and the environment but also to secure radiological and nuclear sources in the DRC and, on the other hand, the types of policies for repairing the damage that populations have suffered and/or continue to suffer.

Based on many information collected in various legal and regulatory documents (IAEA, 2018c; DRC Ministry of Scientific and Technological Research, 2018; RDC Ministry of Scientific and Technological Research, 2002) and other reports (Autorité de Sûreté Nucléaire (France), 2017; Alain Miele and Lebaron-Jacobs, 2005) and works (Ammerich, 2013; Haranger, 2002; Sohier & Hardeman, 2006) that we found during our research, we wish to highlight the shortcomings of the Congolese legal regime in terms of nuclear safety and draw inspiration from international experience in order to suggest better protection for the population and their environment. Thus, in this study, we will identify the existing Congolese legal rules on the prevention and management of risks related to the use of radiological and nuclear materials in order to assess their effectiveness in addressing the problems mentioned above and then to propose appropriate solutions in the light of international legal mechanisms for nuclear safety.

1) Definition of keywords

Nuclear material

Plutonium except that with isotopic concentration exceeding 80% in plutonium-238; uranium-233; uranium enriched in the isotope 235 or 233; uranium containing the mixture of isotopes as occurring in nature other than in the form of ore or ore residue; any material containing one or more of the foregoing [International Atomic Energy Agency (IAEA) 2018 Glossary] (IAEA, 2018b).

The Statute of the IAEA uses the term special fissionable material, with the meaning essentially of nuclear material as defined here, but explicitly excluding source material. For the purposes of IAEA safeguards agreements, nuclear material is defined as "any source material or special fissionable material as defined in Article XX of the Statute of the IAEA".

The Paris Convention on Third Party Liability in the Field of Nuclear Energy uses the term 'nuclear substances', which means nuclear fuel (other than natural uranium and depleted uranium) and radioactive products or radioactive waste.

Radioactive (Radiological) material

Material designated in national law or by a regulatory body as being subject to regulatory control because of its radioactivity (IAEA, 2018a). Any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in paras 401-406 [of the IAEA Transport Regulations].

Risks (Radiation risks)

Detrimental health effects of exposure to radiation (including the likelihood of such effects occurring), and any other safety related risks (including those to the environment) that might arise as a direct consequence (IAEA, 2018a) of:

a) Exposure to radiation;

b) The presence of radioactive material (including radioactive waste) or its release to the environment;

c) A loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation. (See SF-1 [17].)

- For the purposes of the IAEA safety standards, it is assumed that there is no threshold level of radiation dose below which there are no associated radiation risks.
- Safety Requirements and Safety Guides specify the radiation exposures and other radiation risks to which they refer.

Nuclear safety

The achievement of proper operating conditions, prevention of accidents or mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation hazards (IAEA, 2018a). In our study we include in the understanding of nuclear safety all measures put in place both for protection from nuclear material and any radioactive sources (protection of people and the environment from exposure to radioactive material).

Nuclear security

The prevention and detection of, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities (IAEA GOV/2005/50). This includes, but is not limited to, the prevention and detection of, and response to, the theft of nuclear material or other radioactive material (with or without knowledge of the nature of the material), sabotage, and other malicious acts, illicit trafficking and unauthorized transfer (IAEA, 2018a).

In general, security is concerned with malicious or negligent actions by humans that could cause or threaten harm to other humans; safety is concerned with the broader issue of harm to humans (or the environment).

2) Research questions

At natural doses, radioactivity is not dangerous for humans. But at high doses, exposure to radiation or ingestion of radioactive substances can be a health hazard.

Because they concentrate radioactivity, radioactive sources and wastes are dangerous and can pose a health risk for humans and the environment. They come from the plant's purification and filtration circuits, which collect some of the radioactive elements generated by the operation of the facility (tritium, carbon 14, iodine, other fission or activation products, rare gases, etc.). Sorted according to their level of radioactivity and their chemical composition, these elements are stored, and then released in liquid or gaseous form. Normally, the regulations set

thresholds that the operator must not exceed in order to avoid any risk of a significant increase in natural radioactivity in the environment (SFEN, n.d.; Agence National de gestion des Déchets Radioactifs (ANDRA/France), n.d.).

The radiation emitted by the substances they contain is the main risk for humans, who are then exposed to: external irradiation, in the event of proximity to the radiation emitted by the substances contained in the waste and/or internal contamination, in the event of inhalation or ingestion of radioactive substances, from the waste, which would be found in the air or food, etc. Radioactive waste can also present a risk because it contains chemical elements that can be toxic. It must therefore be handled in a specific way and isolated from humans and the environment for as long as it presents risks. For this purpose, they are carefully conditioned and then stored in centres adapted to their nature (Hession et al., 2006).

As far as the DRC is concerned, it should be noted, as stated in the statement made in 2017 by the representative of the DRC government at the 61st ordinary session of the IAEA General Conference, that thanks to the long experience acquired in the operation of its two research reactors, nuclear and radiological safety has improved significantly in the pursuit of compliance with international standards. Indeed, with the establishment of a nuclear and radiological safety infrastructure, a legal, regulatory and institutional framework allows the regulatory control of the nuclear facilities housing these reactors through inspections and relevant recommendations made to the operators. Likewise, users of radioactive sources in different sectors of life have their radiological facilities continuously inspected by the regulations to ensure their safe and secure use (Ministry of Scientifique and Technological Research of the DRC, 2017).

Within the framework of this study, we try to highlight the improvements described above, to evaluate the level of their effectiveness in the protection of the people and the environment and to make suggestions for their strengthening. Thus, on the basis of issues presented in the context of our study introduction and here above, we have identified four research questions in our study:

a) What is the Congolese legal and institutional framework for the prevention and management of nuclear and radiological risks? This will identify the Congolese legal texts in this field.

b) Is the Congolese framework sufficiently compliant to international standards of nuclear security and safety? By presenting the international legal framework of nuclear security and safety, we will be able to examine the question about the compliance of the Congolese legal framework to general international standards and also to existing regional standards.

c) Is the Congolese framework effective in the prevention and management of nuclear and radiological risks? We will examine the recurring problems in the Democratic Republic of Congo and how the Congolese system solves the matters, so we can be able to judge its effectiveness.

d) How to strengthen this framework? Based on the gaps discovered in the Congolese system, we will give some recommendations.

The DRC is a member of the IAEA and has signed several international treaties on the exploitation and peaceful use of nuclear energy. As such, it is obliged to comply with the various recommendations arising from its international commitments and above all to cooperate with the IAEA, which ensures the control and accompaniment of States in this field. Further on, we explain the IAEA's requirements in terms of nuclear safety and how the DRC applies the IAEA's standards in this area.

3) Hypothesis

From the above, we already believe that the solutions to all the questions, as presented here above, could lie, on the one hand, in the integration and strengthening of international nuclear safety and security standards into national legislation, while adapting them to the specific realities of the DRC; and, on the other hand, in the adoption of numerous other mechanisms for the prevention and management of risks related to radiological and nuclear materials in different sectors of public and private services, without neglecting the importance of international cooperation in this field (bilateral, multilateral, regional and sub-regional) to benefit from the experiences of other nations.

4) Methodological approach

The research method in international law is essentially legal, consisting of an analysis of the normative and institutional system often conceived as an "order" and an interpretation of the content of norms and the power of institutions. Legal analysis sometimes leads to a description of reality, in order to improve knowledge of it (law as a science), but it most often aims to found an advisory or prescriptive opinion (law as an art). However, in both cases, it presupposes the learning of a certain formal logic and of an equally formalized technique, the mastery of which is essential (law as a discipline) (Cabanis et al., 2016: p. 44).

For a good study of the framework of prevention and management of nuclear and radiological risks in the Democratic Republic of Congo, we must go through a thorough review of the standards that regulate the sector, and make an analysis of their compliance with international standards before assessing their suitability in solving potential and actual risk. Thus, our study is essentially in the field of law, it goes without saying that, in order to achieve the desired results, we must use legal approaches, in particular the methods of literary interpretation, contextual, systematic, historical and comparative method.

However, risk assessment is a science of uncertainty (Smith, 2000). Regulatory action can be postponed almost indefinitely by questioning the findings or methods of studies that show harm or by insisting that more research is needed before final conclusions can be drawn. In the meantime, air, soil, and water continue to be contaminated and wildlife, workers, consumers, and communities continue to be exposed. Even if it seems difficult (and both an ideal and a utopia) to find a legal formula that would reduce the human and environmental consequences of nuclear to the minimum level of zero risk, because we cannot always completely control the causes of present and future incidents, we still

have to think about measures and mechanisms to put in place. And even if the whole world agrees to abandon the use of nuclear, it remains that the materials and equipment used during a long time will continue to be an international preoccupation both in terms of their safety and security. This justifies the often uncertain and unpredictable nature of environmental and human risks, especially those from nuclear and radiological materials: it is neither always nor never. So according to the precautionary approach, we need to take actions (Wynne, 1992).

Moreover, as today world is full of acts of terrorism, it's important that nuclear power issues remain part of the government policies of States (first subjects of international law) and, at the same time, a matter of collective security. In this sense, States have the duties of establishing legal frameworks within which all other sciences will be moved. Thus, the interdisciplinary approach will allow us to identify and assess the degree of risk in different cases and to apply appropriate standards for their reduction. For this, we must combine the legal proceedings with other scientific approaches, including but not limited to political sciences, administrative and social, public health and environmental sciences... as well as of nuclear sciences. In fact, to prevent and limit the present and future dangers against populations and the environment, the involvement stakeholders is required in the process of strengthening engagements and in mastering new aspects of the problems of nuclear power.

Furthermore, it is already important to mention that we have been limited in our research by the difficulty of collecting more detailed data regarding the operation of the Congolese system on protecting the population and the environment against the risks of nuclear and radioactive materials.

5) Interests of the study

The interest of this study mainly resides at three levels:

a) Highlight the organization of the prevention and management of risks associated with nuclear and radiological materials both at international and national levels.

b) Discover the actual and potential nuclear and radiological risks that deserve special consideration for the suggestion of adapted standards.

c) Offer applicable solutions, starting from observations made, in order to improve the quality of the Congolese legal protection against risks of nuclear and radiological.

2. Nuclear and Radiological Hazards in the DRC

Under this point, it seems important to present both the geographical and geological situation of the DRC, mainly with regard to the main material used in the creation of nuclear energy sources, and to distinguish the categories of risks linked to nuclear and radiological materials that often threaten the DRC population and the environment.

1) Geographical and geological presentation of the DRCongo

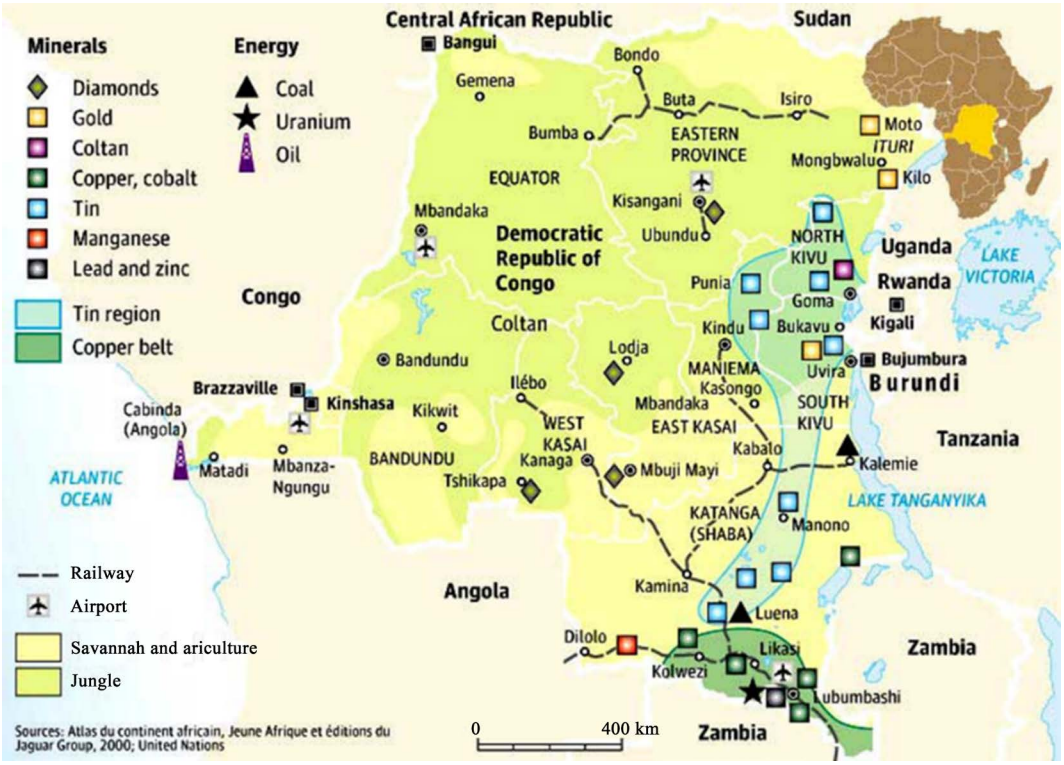
Image 1 here below shows the geographical location of the DRCongo, which is

in Central Africa, surrounded by 9 neighbouring countries.

Image 2, as can be seen, gives a geological representation of the different mineral resources of the DRC, among which uranium constitutes the

Sources: PLANETEAFRIQUE.com.
http://www.afrique-planete.com/republique_democratique_congo/carte_rep_dem_congo.htm accessed on 16th February 2021.

Image 1. Source: PLANETE AFRIQUE.com.



Sources: https://jpmarkifr.wordpress.com/cartes/ accessed on 16th February 2021.

Image 2. Sources: Atlas d'Afrique, Jeune Afrique et éditions du Jaguar Group, 2000, UN.

main raw material for ionising radiation sources, and is mainly found in the south of the country.

2) Categories of nuclear and radiological hazards in the DRC

We have identified 4 main categories of ionizing radiation risks:

Exposure hazards in mining sites: Uranium is present in many parts of Katanga and elsewhere in the country. Often associated in the same rock as cobalt or copper, uranium remains a permanent danger when scrap copper and cobalt are released into the environment by mining operators. But in Congo, unauthorized exploitation of minerals has taken alarming proportions since associated with uncontrolled armed groups. These are the same case of forced works of children and women in dangerous mines without safety and security measures. Although, the artisanal exploitation is prohibited, but there is lack in enforcing of the law.

Natural exposure risks: Pollutions of rivers and lands by various industries and hazardous activities are reported, although these rivers are the main resources in drinkable waters (i.e. the case of the Mura River near Shinkolobwe: a vehicle have dumped a large shipment of irradiated raw minerals in the river).

Illicit trafficking of Radioactive Sources: The country's borders are not fully secured; cross border traffic can proceed at all corners of the country, particularly in its eastern part where illegal armed groups continue to operate.

Exposure risks due to degradation of nuclear facilities: In DRC, the major risk is the state of disrepair of the University of Kinshasa site that hosts the nuclear reactors owned by the country for its nuclear research. Erosions seriously threaten buildings housing the reactors.

Though it was put off since 2004, unable to renew the equipment from the manufacturer because of a US embargo from the 1990s. The reactor remains in a good condition as reported by inspectors of the IAEA every year. The collapse of the site has become very dangerous for people and the environment (in the Campus of the University of Kinshasa and its neighbourhoods)

3. International Legal Framework for Nuclear Safety

In general, the international framework of nuclear and radiological security and safety is composed of international regulations (binding and non-binding) and international structures (bodies and mechanisms). The components of the legal system for prevention and management of risks related to nuclear materials are the followings:

- Conventions, treaties and other international agreements adopted under the United Nations (UN) framework and under the International Atomic Energy Agency (IAEA) framework.
- International agreements signed in the context of some regional governmental organizations, as well as some of the legal standards adopted for the implementation of those agreements.
- Other bilateral and multilateral treaties containing provisions for prevention

and management of nuclear risks.

1) Conventions, treaties and other international instruments adopted under the United Nations (UN) framework and under the International Atomic Energy Agency (IAEA) framework

With regard to the conventions and treaties adopted under the auspices of the United Nations, it is important to recall that it was after the bombings of Hiroshima and Nagasaki in October 1945 (Union of Concerned Scientists, 2013) that the United Nations recognized not only the destructive capacity of newly discovered nuclear energy, but also the urgent need to establish international legal mechanisms to limit the threat and use of nuclear weapons and to promote the peaceful use of nuclear energy, while preserving life and the environment from the risks that this may entail.

a) The IAEA Statute

The IAEA Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA, held at UN Headquarters. It entered into force on 29 July 1957.

According to article 2 of its Statute, the IAEA main mission is to promote the use of nuclear energy for peace, health and prosperity throughout the world and to ensure that nuclear power is not used for military purposes. For this, the IAEA establishes and administers measures to ensure that special fissionable and other products, services, equipment, facilities and information provided by the Agency or at its request or under the direction or under control are not used in order of military purposes; and to extend the application of safeguards to particular activities of the State in the field of atomic energy. According to article 3, A, 5 & 6 of its statute, regarding prevention against nuclear and radioactive hazards, the IAEA establishes, adopts safety standards and makes arrangements to enforce them to protect health and minimize danger to people and property (including such standards for labor conditions), to its own operations and as well to those of the parties which have requested its assistance.

b) UN Treaties and Resolutions adopted for the regulation of outer space area

Several other international legal instruments adopted in the UN framework contain some clauses with the objective of preventing the dangers arising as expanding the use of nuclear weapons. In particular, treaties and resolutions for the regulation of Outer Space area are worth quoting:

- The 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (General Assembly resolution 2222 (XXI), annex, adopted on 19 December 1966, entered into force on 10 October 1967) could be viewed as furnishing a general legal basis for the peaceful uses of outer space and providing a framework for developing law of outer space. With regard to the protection of persons and the environment, Articles V, IX and XI establish the obligation to conduct the exploration so as to avoid their harmful contamination and harmful modifications of the Earth's environment resulting from

the introduction of extraterrestrial material and, if necessary, to adopt appropriate measures to this end and to inform immediately the other States Parties to the Treaty or the UN Secretary-General on nature of their activities, also of any discovered phenomena which might constitute a danger to the life or health of astronauts.

- The 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Resolution 34/68, annex, adopted on 5 December 1979, opened for signature on 18 December 1979, entered into force on 11 July 1984) prohibited for States Parties to place in orbit around or other trajectory to or around the Moon objects carrying nuclear weapons. The article 7 requires States Parties to take measures to prevent the disruption of the existing balance of its environment, whether by introducing adverse changes in that environment, by its harmful contamination through the introduction of extra-environmental matter or otherwise. States Parties shall also take measures to avoid harmfully affecting the environment of the Earth through the introduction of extraterrestrial matter or otherwise, in exploring and using the Moon.
- The 1992 UN Resolution on Principles Relevant to the Use of Nuclear Power Sources in Outer Space adopted on 14 December 1992 (resolution 47/68) emphasizes on the recognition that the use of nuclear power sources in outer space should be based on a thorough safety assessment, including probabilistic risk analysis, with particular emphasis on reducing the risk of accidental exposure of the public to harmful radiation or radioactive material.

c) Other treaties adopted under the UN auspices

Moreover, it is important to note that, after the 11th September 2001 World Trade Center attack, the concern to prevent and fight crime based on the use of nuclear and radiological materials pushed the UN to adopt, on 4th September 2005, the International Convention for the Suppression of Acts of Nuclear Terrorism (effective since 7th July 2007). Indeed, it was found that it would be unfortunate if the nuclear material is used in the commission of acts of nuclear terrorism which could have the most serious consequences and pose a threat against international peace and security. The agreement has two objectives, including in one hand the adoption by States Parties of effective measures and practices to prevent such terrorist acts and to prosecute and punish perpetrators[1], and in the other hand the strengthening of nuclear security measures, but also to reinforce existing mechanisms regarding the physical protection of nuclear materials. Though, this agreement reconciles the nuclear security issues more than safety issues, nevertheless it requires States Parties to adopt appropriate measures to ensure the protection of radioactive material, taking into account relevant recommendations and functions of the IAEA applicable in the

[1]Possession, manufacture, use and illicit use of radioactive materials and devices with intent to cause death or to cause bodily injury to a person or cause damage to the environment, whether through threat against a person, organization or government, attempt and cooperation to the commission of such acts are punishable offenses under this agreement, provided there is a foreign element.

matter. And having seized radioactive material, devices or nuclear facilities or have taken otherwise control of these materials, device or facility after the commission of an offense referred to in Article 2, the State Party which holds must take the necessary measures to neutralize the radioactive material, device or nuclear facility and/or to ensure that any nuclear material is held in accordance with applicable safeguards of the IAEA, while considering the recommendations for physical protection, health and safety standards published by the IAEA, whose Director General have to be informed about measures taken.

There are other conventions, treaties and/or resolutions adopted under UN's auspices, in the framework of nuclear security, providing also some clauses for the protection of persons' health and the environment. We can note for example the penultimate paragraph in the preamble of the Comprehensive Test-Ban Treaty (CTBT), adopted on 10 September 1996[2], which expresses the hope that this Treaty could contribute to environmental protection[3].

This is also the case of the Treaty on the Non Proliferation of Nuclear Weapons that considers in its preamble, without making a prescription, that the devastation that a nuclear war might cause upon all mankind implies that we should unify all efforts to prevent the risk of such a war and to take measures to safeguard the security of peoples[4].

d) Treaties and other standards adopted under the IAEA's auspices

Several conventions on nuclear safety have been adopted in the context of recognized competences to the IAEA under its Statute. This is the case of these conventions:

i) Convention on the physical protection of the nuclear materials (adopted in 1979). The development and expansion of international transport of nuclear material and the protection and safety requirements have led to the adoption of this Convention whose content is based on the IAEA recommendations issued in 1972. This agreement is considered to be a very useful tool because it reconciles security, non-proliferation and physical protection to which it adds general recommendations on nuclear safety (Odette Jankowitsch-Prevor, 2010; Carlton Stoiber et al., 2003). It provides for minimum common levels of physical protection of nuclear material in international transport. It also establishes cooperation between the parties to prevent offenses related to nuclear and requires them to suppress offenses under their domestic law.

Following the attacks of September 11, 2001 in the United States, this agreement was subject of an amendment, adopted on 8 July 2005 in Vienna under the

[2](UN Office of Disarmament, n.d.) The treaty will enter into force 180 days after the 44 states listed in Annex 2 of the treaty have ratified it. These "Annex 2 states" are states that participated in the CTBT's negotiations between 1994 and 1996 and possessed nuclear power reactors or research reactors at that time. As of 2016, eight Annex 2 states have not ratified the treaty: China, Egypt, Iran, Israel and the United States have signed but not ratified the Treaty; India, North Korea and Pakistan have not signed it.

[3]Democratic Republic of Congo has signed on 4 October 1996 and submitted its ratification 28 September 2004.

[4]More information about the Non Proliferation Treaty can be found here http://legal.un.org/avl/ha/tnpt/tnpt.html.

aegis of the IAEA, which extends the legal obligations on physical protection of nuclear materials during their use, storage and domestic transport.

The amendment entered into force on 8 May 2016, in accordance with Article 20, paragraph 2, of the Convention. Up to 21 September 2020, there are 125 States and organizations which have accessed, accepted, approved or ratified the amendment, subject to their dates of entry into force (IAEA, 2020).

ii) Convention on Early Notification of a Nuclear Accident (entered into force October 27, 1986). Each Contracting Party to this Convention agrees to notify and inform in the shortest possible time, the international community of any event taking place on its territory or may have resulted in uncontrolled dispersal of radioactive material in the environment, likely to have cross-border consequences. These exchanges of information should help to limit the radiological consequences and allow all States to take, if necessary, the protection of their populations.

iii) Convention on international assistance in case of nuclear accidents and radiological emergencies (entered into force on 26 February 1987). To improve the operational implementation of international assistance, the IAEA has established an international network of response to requests for assistance in case of radiological emergency. The data-base Response Assistance Network (RANET), developed by the IAEA, lists national capacities that can be made available to another State within the framework of the implementation of the Convention on Assistance.

iv) Convention on Nuclear Safety (entered into force on 24 October 1996). The Convention on Nuclear Safety was adopted in Vienna on 17 June 1994. Its aim is to legally commit participating States operating land-based nuclear power plants to maintain a high level of safety by setting international benchmarks to which States would subscribe. This Convention is the first international legal instrument ever developed specifically on the safety of nuclear installations. The contracting countries shall in particular put in place a legislative, regulatory and administrative framework to the objectives of the Convention and to fulfill its obligations, establish a regulator and independent control with an authority, competent and sufficient human and financial resources and develop national reports on the implementation of their commitments under the Convention and submit these documents to the "peer reviews" to be made by all countries in the meetings of Contracting Parties held every three years. This mechanism was the main innovative and dynamic element of the Convention.[5]

The obligations of the Parties are based to a large extent on the principles contained in the IAEA Safety Fundamentals document "Fundamental Safety Principles (SF-1)" (IAEA, 2020). These obligations cover for instance, site, design, construction, operation, the availability of adequate financial and human resources, the assessment and verification of safety, quality assurance and emer-

[5]Point viii) of the Preamble: Recognizing that this Convention entails a commitment to the application of fundamental safety principles for nuclear installations rather than of detailed safety standards and that there are internationally formulated safety guidelines which are updated from time to time and so can provide guidance on contemporary means of achieving a high level of safety 3.

gency preparedness.

v) Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (adopted in 1997). The Joint Convention is complementary to the Convention on Nuclear Safety and is based on a similar mechanism to review every three years.

The obligations of the Contracting Parties with respect to the safety of spent fuel and radioactive waste management are based to a large extent on the principles contained in the IAEA Safety Fundamentals document "The Principles of Radioactive Waste Management", published in 1995.

They include, in particular, on one hand, the obligation to establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management and, on the other hand, the obligation to ensure that individuals, society and the environment are adequately protected against radiological and other hazards, inter alia, by appropriate sitting, design and construction of facilities and by making provisions for ensuring the safety of facilities both during their operation and after their closure.

The Convention imposes obligations on Contracting Parties in relation to the trans-boundary movement of spent fuel and radioactive waste based on the concepts contained in the IAEA Code of Practice on the International Trans-Boundary Movement of Radioactive Waste.

vi) IAEA Code of Conduct on the Safety and Security of Radioactive Sources, and supplementary Guidance on the Import and Export of Radioactive Sources. The Code was published by IAEA in January 2004. The code is designed to limit the harmful effects of these sources by encouraging the States Parties to the development, harmonization, strengthening and implementation of policies, laws and regulations (related with radiological safety and security) as well as of transport cooperation and transfer of radiological sources. The aim is to achieve a high level of safety and radiation safety. Several improvements are regularly made to the code to meet current radiation safety and security requirements. For example, at the request of the General Conference (GC (49)/RES/9/A9), a formalized process for the periodic exchange of information and lessons learned from the assessment of States' progress in implementing the provisions of the Code was established, which was developed in June 2006 and subsequently approved by the IAEA Board of Governors. The revised guide was published in May 2012.

vii) IAEA Code on the safety of research reactors (IAEA, 2006b).

The Code of Conduct for the Safety of Research Reactors was adopted in September 2004. Its objective is to achieve and maintain a high level of safety of civilian research reactors worldwide through the enhancement of national measures and international cooperation including, where appropriate, technical cooperation in the field of safety. However, unlike the Code of Conduct on the Safety and Security of Radioactive Sources and its supplementary guidance, no process is currently scheduled for States to take " political commitment " to apply the

guidelines of the Code. The resolution GC (48) /RES/10/A.8 of the General Conference in September 2004 simply encourages States to apply the guidelines in the Code to the management of research reactors (Rautenbach & Tonhauser, 2006).

e) IAEA safety standards relevant to the DRC case

Though many other standards were established and are applied in accordance with Article III.A.6 of the IAEA Statute to ensure the safety and security regarding the use of nuclear energy for peaceful purposes, the IAEA standards applicable and adaptable to the case of the DRC are especially the standards contained in these two documents:

- Fundamental Safety Principles, In IAEA Safety standards, Safety Fundamentals No. SF1, 2007 and
- Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements publication, In IAEA Safety Standards Series No. GSR Part 3, 2014.

We will develop about their relevance later.

2) International instruments signed in the context of some regional governmental organizations, as well as some of the legal standards adopted for the implementation of those agreements

After an overview of nuclear safety and security standards at the global level, we have found that in the context of the European region there are European Atomic Energy Community (EURATOM) nuclear standards (European Parliament, n.d.), on the one hand, and OECD/NEA nuclear standards, on the other. Indeed, EURATOM standards are binding on all European states. With regard to the protection of persons and the environment, Article 37 of the EURATOM Statute (Burkhard Heuel-Fabianek et al., 2008), signed on 25 March 1957, seems more effective. As for the Nuclear Energy Agency of the Organization for Economic Cooperation and Development (OECD/NEA) (OECD/NEA, n.d.) standards, they only have the legal force of recommendations vis-à-vis the States Parties. However, given that these standards only concern European States and are therefore not binding in the case of the DRC, we have decided not to take them into account in our analysis.

From one region to another, we discovered the African Nuclear-Weapons-Free Zone Treaty, also known as the Treaty of Pelindaba (Signed at Cairo on 11 April 1996 and entered into force on 15 July 2009) (United Nations Office on the Disarmament (UNODO), 1996), which was signed by 47 of the continent's 53 states, and prohibits states from conducting research on, developing, manufacturing, stockpiling, acquiring, possessing, or having control over any nuclear explosive device by any means anywhere. Parties are also banned from receiving assistance on research or development, and cannot station any nuclear explosive device on their territory. Encouragement for a state that breaks any component of this Treaty is also prohibited. Evoking the guidelines contained in the Bamako Convention on the Ban on the Import into Africa and the Control of Trans-

boundary Movements and Management of Hazardous Wastes within Africa as they relate to radioactive waste, States-Parties do have the decision regarding whether or not to allow foreign ships and aircrafts to pass through their borders (Article 7 (a) and (b)). However, the treaty does not prohibit from peaceful nuclear activities but States are obligated to undergo verification by the IAEA (Article 6 para. c and d).

It follows that, as with other international conventions and treaties, the Pelindaba Treaty is more concerned with nuclear security objectives than with safety objectives. Indeed, even if it makes peaceful use conditional on IAEA assistance or refrains States Parties from supplying radioactive materials, equipment or other radioactive materials to any other State, outside the IAEA Safeguards Agreement (Article 8), and requires them to maintain the highest standards of security and effective physical protection of materials, nuclear facilities and equipment to prevent theft or unauthorized use and handling in accordance with physical protection measures equivalent to those provided for in the Convention on the Physical Protection of Nuclear Material and the recommendations and guidelines developed by the IAEA for this purpose (see Article 10), all this is aimed at ensuring nuclear security in a more appropriate way rather than nuclear safety.

If, through its signature on 11 April 1996, the DRC marked its adherence to the spirit of the texts contained in the said treaty, which would at least lead it to refrain to commit acts in violation of the said treaty, nevertheless it appears that due to the absence, to date, of its act of ratification, the DRC is not likely to feel fully bound by this treaty and to implement it scrupulously. For this reason, in addition to the fact that the treaty is more concerned with nuclear security objectives, while referring to the IAEA standards for all peaceful use, we found it inappropriate to take it into account in our analysis of compliance with international nuclear safety standards of the Congolese system for the protection of people and the environment against the risks of ionizing radiation.

From the above, we find that the rules of international nuclear law proceed from several different sources. First, they come from the conventions and treaties, on the other hand, they are from the standards and recommendations of international organizations working in the field of nuclear and/or radioactive materials. Hence, we need to examine their legal values to understand the extent of their binding force, if any, toward the Member States, especially towards the DRC.

3) Legal value of international rules for the prevention and management of nuclear and radiological risks

According to Prof Besson (Prof. Besson, 2009), despite Article 38 of the International Court of Justice (ICJ), there is no hierarchy between norms of public international law. Nevertheless, there are a number of principles that apply in case of conflict:

a) A jus cogens norm (prohibition of slavery, trafficking in human beings,

genocide, aggression and forced labour, respect for the pacta sunt servanda, good faith, sovereign equality of States...) prevails over any other norm, whatever its source.

b) According to Article 103 of the Charter of the United Nations, obligations under the Charter prevail over treaty obligations under other treaties.

c) Norms relating to the protection of human rights prevail over other norms.

d) The general principles of "lex posterior derogate legi priori" and "lex specialis derogate legi generali" also apply to public international law.

The question of the legal force of UN and IAEA international standards for the prevention and management of nuclear and radiological risks seems to be less important in the first instance, as we already know from Article 38 of the ICJ Statute, which gives different categories of sources of international law, and in accordance with Article 26 of the Vienna Convention on the Law of Treaties stating that parties are under an obligation to perform treaties in good faith.

Fundamentally, most of the provisions relating to nuclear safety and security mentioned above have their source in conventions, treaties and international agreements duly concluded by the States Parties; they are therefore binding on the signatory States as they are based on the fundamental objectives of protection of life and the environment which are internationally recognised general principles of law. Nevertheless, the actual extent of the legal force of the commitments of States Parties to comply with the prescribed provisions, especially with regard to the establishment of effective measures for the prevention and management of nuclear and radiological risks in their national law and system, depends on the extent of the meaning of the provisions of these conventions, treaties and other norms mentioned above. It has been noticed, on the other hand, that most of these texts are silent as to the sanctions or other responsibilities that State Parties would incur for the non-execution of the provisions of these instruments.

The contents of these texts are often unclear as to the nature of the (mandatory) actions that States Parties must undertake, in practice, for a number of different reasons. The safety standards use the form 'shall' in establishing international consensus requirements, responsibilities and obligations. Many requirements being not addressed to a specific party; the implication is that the appropriate party or parties should be responsible for the way of fulfilling them. Recommendations are expressed as 'should' statements in the main text (body text and appendices), indicating an international consensus that it is necessary to take the measures recommended (or equivalent alternative measures) for complying with the requirements (IAEA, 2006a).

This is justified with regard to the texts of treaties and conventions adopted before 1986, the main objective at that time was the race for nuclear disarmament. Thus, safety issues are quite secondary to security issues. Also, this was a period of experimentation in nuclear research for peaceful purposes, and it was still very early to discourage this new industry from taking root because expecta-

tions in terms of energy opportunities for economic development were too high.

However, following accidents with devastating consequences in nuclear facilities, States Parties increased the number of international safety agreements for nuclear facilities and radioactive sources, including requirements for notification and mutual assistance in the event of an accident or radiological emergency, in addition to those on security. Thus, since 1986, safety objectives seem to go hand in hand with security objectives.

And as it appears that the commitments of the States in favour of final nuclear disarmament were made imprecise, in terms of completion schedule, with the consequence that the conventions and treaties concerned are never ratified or with difficulty or partially implemented, for lack of clearly prescribed sanctions, it seems plausible that only other dangerous and/or tragic events could push States to make further progress in the field of safety and security, in a slightly more restrictive manner. As States do nothing without (pressing) interest, there has been for some time now a kind of laxity in concluding the more binding conventions and/or treaties, yet they are eagerly awaited by humanity.

In fact, as there is more to be gained than lost here for the good of all mankind, and there is no need to wait too long, part of the standard-setting process has been opened up for more expertise and speed, and there is an intensification of standard-setting activity within the IAEA by the Committees and/or the Commission on Safety, with the support of other international organizations. There is a growing number of experts from other organizations working in the same field who had been involved in the preparatory work for IAEA safety and security standards, codes of conduct, guides, etc...

Indeed, we must remember that the IAEA Statute, in its article III[6], makes the safety standards binding on the IAEA in relation to its own operations and on States in relation to operations assisted by the IAEA. Any State willing to enter into an agreement with the IAEA concerning any form of Agency assistance is required to comply with the requirements of the safety standards that pertain to the activities covered by the agreement (IAEA, 2006a).

Therefore, the standards contained in International conventions are directly binding on contracting parties. They are considered as Safety Fundamentals and used as the basis for the development of the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The Safety Requirements on Preparedness

[6](IAEA, 2014)

By virtue of that provision the Agency is authorized:

> "To establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property (including such standards for labour conditions), and to provide for the application of these standards to its own operations as well as to the operations making use of materials, services, equipment, facilities, and information made available by the Agency or at its request or under its control or supervision; and to provide for the application of these standards, at the request of the parties, to operations under any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of atomic energy."

and Response for a Nuclear or Radiological Emergency (IAEA, 2015) reflect the obligations on States under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

The safety standards, incorporated into national legislation and regulations and supplemented by international conventions and detailed national requirements, establish a basis for protecting people and the environment. However, there will also be special aspects of safety that need to be assessed case by case at the national level.

From all of the above, after our analysis of the relevance and applicability of international nuclear safety and security standards to the case of the protection of people and the environment in the DRC, we identified, already at this level of our study, the following persisting issues:

1) The pre-eminence of nuclear security objectives and the impertinence of taking effective account of safety objectives, in particular the protection of people and the environment:

First, most of the conventions and treaties adopted before 1986 mainly concern nuclear security issues. Many conventions adopted after the Chernobyl accident in 1986 slightly tackle the issue of protecting people and the environment against nuclear and radioactive risks, without making them mandatory. Indeed, States tend to leave the IAEA the responsibility of precisely defining the safety objectives through secondary texts (safety standards), thus avoiding being bound in a more restrictive way. However, to some extent there are growing provisions requiring States parties to take appropriate measures to protect people and the environment from the dangers of nuclear radiation.

2) Legal binding force of the nuclear safety standards[7] are limited:

After analysing different standards and at different levels (global and regional), we have found that the IAEA standards are only binding vis-à-vis the IAEA in the context of all its activities and vis-à-vis the States if they request assistance of the IAEA. On the other hand, EURATOM standards are only binding to all EU States, while OECD/NEA's standards have just recommendatory value for its States parties.

Moreover, although supposed to have binding force on States-Parties, the provisions on nuclear safety provisions contained in nuclear conventions or treaties are often not formulated in such a way as to require their compulsory application at the domestic level. States have the latitude not to take them into account and/or to apply them totally or partially. This justifies the disparity in the levels of execution of these conventions by the States-Parties.

3) The lack, within conventions and treaties, of clear and precise definitions of

[7]Paragraph 1.1. of "The Agency's Safety Standards and Measures" (INFCIRC/18), which was revised in 1975 and approved by the IAEA Board in February 1976 (reproduced in INFCIRC/18/Rev.1) give this definition: "Safety standards" means standards, regulations, rules or codes of practice established to protect man and the environment against ionizing radiation and to minimize danger to life and property.

the mechanisms to be put in place by States Parties to protect people and the environment at the domestic level and the lack of sanctions and other forms of liability:

On the basis of the objectives and principles in international conventions and treaties, the development and control of specific nuclear safety and security standards are entrusted to the IAEA bodies in their periodic activities, but also to certain other international organizations working in development of standards. The real measures to be taken by States Parties are therefore to be found rather in the safety standards.

At the same time, most of the conventions and treaties in this area do not prescribe penalties for failure to implement or for violation of treaties in terms of State Party liability.

This being said, what are the fundamental objectives and basic principles contained in the applicable IAEA standards for the protection of people and the environment in the DRC?

4) IAEA applicable standards in the DRC case

As already said before, the IAEA standards applicable and adaptable to the case of the DRC are especially the standards contained in these two documents:

- Fundamental Safety Principles No. SF1, 2007 (In IAEA Safety standards Series) (IAEA, 2006c),
- Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements publication No. GSR Part 3, 2014 (IAEA, 2014) (In IAEA Safety Standards Series).

a) The 2007 IAEA Fundamental Safety Principles No. SF1

The fundamental safety objective emphasised in this document concerns the necessity "to protect people and the environment against the harmful effects of ionizing radiation". This goes through the monitoring of the radiation exposure of people and the release of materials radioactive in the environment, the restriction of all the likelihood of events that can lead to loss of control of the core of a nuclear reactor, a chain reaction, a radioactive source or any other source of radiation and the mitigation of the consequences in case of such events.

This IAEA Basic Safety Standards (IAEA BSS also) provides 10 principles applicable to all activities, materials and facilities:

***Principle* 1.** *Responsibility for safety*: The prime responsibility for safety must rest to the person or organization responsible for facilities and activities rise to radiation risks.

***Principle* 2.** *Role of Government:* An effective legal and governmental framework for safety, including an independent regulatory body, must be established and maintained.

***Principle* 3.** *Leadership and management for safety:* Capacity management and effective safety management must be established and maintained in organisms dealing with radiation risks and facilities and activities that give rise to such risks.

***Principle* 4.** *Justification of facilities and activities:* Facilities and activities that

result in radiological hazards must be broadly useful.

***Principle* 5.** *Protection Optimization:* Protection must be optimized to provide the highest level of safety that can reasonably be achieved.

***Principle* 6.** *Limitation of risks to individuals*: Radiological risk control measures must protect against any unacceptable risk of harm.

***Principle* 7**. *Protection of present and future generations*: Generations and the current and future environment must be protected against radiological hazards.

***Principle* 8.** *Prevention of accidents*: Everything must be concretely implemented to prevent nuclear or radiological accidents and mitigate their consequences.

***Principle* 9.** *Preparation and conduct of emergency*: Steps must be taken to the preparation and conduct emergency response in case of nuclear or radiological incidents.

***Principle* 10**. *Protective actions to reduce*: Protective actions to reduce existing radiation risks or unregulated must be justified and optimized.

b) The 2014 IAEA Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards No. GSR Part 3:

This document provides the conditions to achieve, as much as possible, the level of internationally accepted optimal safety to protect people and the environment against the harmful effects of radiation in different circumstances of exposures to ionizing radiation. It also presents the requirements to secure control of radiation sources. The document is that the risk of radiation shall be reduced to the lowest possible level that can be achieved, while not restricting the use enjoyed by the society. Thus, the international basic safety standards established target for the assessment, management and control of exposure to radiation.

5) Convention and treaties adopted by the DRC in the field of International Nuclear Security and safety:

To date, concerning the nuclear security field, the DRC has signed, accepted, acceded to or ratified the conventions and treaties below:

- IAEA Statute: party to the Statute of the IAEA since 1961, the DRC has engagement of using its nuclear energy for peaceful purposes and to conduct its nuclear activities under the IAEA control.
- Treaty on the Non-Proliferation of Nuclear Weapons of July 22, 1968: The DRC signed on 22nd July, 1968 in Washington.
- Treaty on the complete prohibition of nuclear tests signed and ratified on 04 October 1996 (Not yet entered into force).
- African Nuclear Weapons Arms Free Treaty, called Pelindaba Treaty entered into force on 15th July 2009: The DRC signed on 11th April 1996 but has not ratified it.
- New York International Convention for the Suppression of Nuclear Terrorism of April 13 2005 (ratified since September 23, 2010)

Concerning the nuclear safety field, the DR Congo has signed, accepted, ad-

hered and/or ratified, among others, the following conventions, treaties and/or codes:

- Convention on the Physical Protection of Nuclear Material on 08th February 1987: The DRC became party since 21st September 2004, but has not yet joined the Protocol that has entered into force on 08th May 2016;
- The Convention on Early Notification of Nuclear Accidents and the Convention on international assistance in case of nuclear accidents and radiological emergencies (signed by the DRC on 30 Sept. 1986 but not yet ratified);
- IAEA Code of Conduct on the Safety and Security of Radioactive Sources.

However, the DRC is not party to two other important conventions addressing the issue of protecting persons and the environment:

- Convention on Nuclear Safety and the Joint Convention on Safety of spent fuel management, and
- The convention on the Safety of Radioactive Waste management.

4. Congolese Domestic Legal and Institutional Framework for Protection against Nuclear and Radiological Risks

In this section, we will analyze the Congolese normative framework for the prevention and management of risks related to nuclear and radiological materials, highlighting, on the one hand, the shortcomings in the normative system, and on the other hand, making proposals to strengthen its effectiveness, based on international standards. In the same way, we will analyze, on the other hand, the institutional framework of the protection against the radiological and nuclear risks, trying to bring out the insufficiencies and proposing solutions to reinforce the effectiveness of the system.

1) Analysis of the Congolese normative framework for the protection of people and the environment against risks related to radiological and nuclear materials.

Beyond the conventions and treaties duly ratified, the legal framework for the protection of people and the environment against the risks related to nuclear and radiological materials in the DRC includes the 2006 constitution as amended to date, the Law No. 017/2002 of 16/10/2002 laying down rules for the protection against the dangers of ionizing radiation and the physical protection of nuclear materials and facilities and the Decree No. 05/022 of 29 March 2005 regulating the protection against the dangers of ionizing radiation.

a) The relevant provisions of nuclear and radiological protection of persons and the environment in the Congolese legal system:

Indeed, under article 16 of the Constitution, it is compulsory for the State to protect human being. The Article 53 guarantees the right to a healthy and conducive environment for its full development; it empowers the individual in charge of environmental safeguard, while making the protection of the environment a duty of the State. Concerning the prevention of cases of irradiation by radioactive substances or waste, pollution affecting the life and health of people

and the environment, Articles 54 and 55 of the Constitution requires the legislature to condition 'licensing of creation and operation of industries, and other activities, with the compliance with environmental standards.

The Law No. 017/2002 of 16/10/2002 laying down rules for the protection against the dangers of ionizing radiation and the physical protection of nuclear materials and facilities provides the Congolese basic security and safety objectives and principles. As Safety Objectives this law provide for "the Protection of people and especially of workers and the environment against the harmful and unwanted effects of ionizing radiation, the establishment of mechanisms which not only limit the possibility of the occurrence of a radiological emergency, but also reduce consequences to the lowest possible level (Article 2, a, b of the Law n° 017/2002), and ensure the safety of nuclear facilities, nuclear and radioactive materials and radioactive waste for which effective measures must be taken to limit or reduce their danger to people and the environment (Article2, e).

The security objectives concern the protection of installations against sabotage, the establishment of adequate means against illegal abductions of nuclear materials, devices for rapid recovery of lost control over the sources by the State (Article 2 c, d, e).

Concerning the Basic Principles of protection against the dangers of ionizing radiation, Article 5 of the Law states that any practice or activity involving exposure to ionizing radiation is subject to prior authorization. This authorization is granted only if the practice or activity complies with the following basic principles:

- Do not involve uncontrollable risks to the health and safety of exposed persons and the population in general;
- Duty include the implementation measures and precautions to ensure optimal protection of people, property and the environment;
- Be undertaken by qualified persons professionally in ensuring accountability, supervision and with appropriate infrastructure;
- Be likely to produce a positive net benefit, keep exposure to radiation as low level as reasonably achievable taking into account existing socio-economic factors and limit exposure doses to levels set by the current regulations;
- The obligation to comply with basic IAEA standards for protection against ionizing radiation in case of any practice or any activity involving radiation exposure (Article 6 of the Law under review);
- The prohibition of employment of persons under 18 and pregnant women in all activities involving exposure to sources of ionizing radiation (Article 7).

The Decree No. 05/022 of 29/3/2005 regulating the protection against the dangers of ionizing radiation aims to prescribe individual protection requirements for society and for the environment against exposure to ionizing radiation and the safety requirements of radiation sources, pursuant to Law No. 017 / 2002 of 16 October 2002 concerning provisions for the protection against the dangers of ionizing radiation and the physical protection of nuclear material and facilities, especially under titles 1 and 2. Among the fundamental principles enforced

by this decree, we list:

- The prior authorization before any activity involving radioactive materials or devices emitting ionizing radiation (Article 49 of the Decree);
- Limitation of exposure doses: fixing reasonable annual dose limits for radiation exposure to which workers, the public and the environment can be exposed to different exposure classes;
- Classification of Institutions (having nuclear facilities) and categorization of radioactive substances by the radioactive energy emission levels for each activity to determine the type of authorizations (Article 60) to be issued;
- Responsibility of the license holder to take administrative and techniques measures for assessment of exposure risks of worker and the environment;
- Prior opinion of the doctor before hiring for jobs where there is risk of exposure proved;
- Optimization: the benefits of exposure to ionizing radiation must be significantly higher than the losses that exposure is likely to cause;
- Justification: ionizing radiation exposure should be the last alternative to be among the possibilities involved, while respecting the dose limits.

The Decree also provides exceptional case of exposure above the limits, but always with permission of National Centre for the Prevention against Ionizing Radiation (CNPRI). For example, the limits of exposure at doses of emergency operations are those set by the IAEA in accordance with Articles 5 and 6 of Law No. 017/2002 of 16 October 2002 on the provisions relating to the protection against the dangers of ionizing radiation and physical protection of nuclear material and nuclear facilities.

b) Shortcomings found in the Congolese legal framework for radiation risks protection:

We have identified 6 major failures in the Congolese system of protection against nuclear and radiological risks, namely:

Gaps in the provisions on civil nuclear liability

This legal vacuum can lead to many violations of rights, to the detriment both for the victims of accidents and for holders of authorizations. Indeed, this vacuum can not only promote an unjustified decision that give advantage to one party over the other, but it can also work against the judge himself who is obliged to create standards on non-solid foundation. Furthermore, it still remains very important to know to which level can extend the liability, and musing on what can reasonably be eligible. This legal vacuum is even more amplified internationally because the DRC has signed so far no agreement on civil nuclear liability.

This legal vacuum is even more amplified internationally because the DRC has signed so far no agreement on civil nuclear liability.

Less favourable standards for nuclear safety

Legal provisions, particularly in the Law n° 017/2002, extend over the issue of nuclear security than safety. The safety protection should be seen first of all in

relation to measures and techniques implemented or to be implemented to contain radioactive emissions at the least harmful possible level for workers, members of the public and the environment.

Gaps in the Principle of Responsibility of the authorization holder

This IAEA BSS principle charge the authorization holder to ensure safe control of all radioactive material used and of all radioactive waste products because its effects can span many generations. The Congolese legal texts are not sufficiently effective in the management of radioactive waste. The ban on polluting the environment should be a strict obligation, in the absence of a clear legal principle of "polluter pays".

Article 41 requires prior authorization for release into the environment that exceed the limit levels of Article 28, but the conditions and terms of this authorization shall be fixed by Inter-Ministerial Order on the proposal of CNPRI (regulatory authority). To date, this order was never caught, while cases of pollution by nuclear waste or radioactive substances released into the environment (case Mura River in Likasi) continue to occur.

Gaps in Principle "Role of Government"

This principle in IAEA system means that for all cases where the responsibility of the license holder is not engaged wholly or partially, it must return to the government to take measures to protect the population and environment.

Existing regulations in Congo do not clearly describe the responsibility of the State and of the regulatory authority regarding cases not falling and/or cases partly under the responsibility of the license holder. And, to date, it is still not yet established a contingency plan in case of emergency approved by the Minister of scientific research as provided for timidly in Article 22 of Decree No. 05/022 of March 29, 2005.

Gaps in transport safety requirements

Apart from Article 28 of the texts of Law 017/200 that provides: " Except for overriding safety considerations, the package of nuclear materials is transported in closed vehicles, compartmentalized or locked containers ", no other transport safety requirement is planned in the whole text of the Law 017/2002 as well as in the Decree.

Gaps in International Commitments

The DRC signed in 1986 the Convention on Early Notification in the event of Nuclear Accidents and the Convention on Mutual Assistance in case of nuclear or radiological emergency, but it has not so far ratified them. However, reference is made to the two conventions in the Law 017/2002, in order to receive international support in case of nuclear accident in DRC. Many other conventions still not signed and/or ratified by the DRC.

c) Possible normative solutions:

Despite these normative and institutional shortcomings, it remains possible to improve things and thus save the situation. For this we suggest:

Adjustment of the concept "responsibility"

This goes through:

- Improving the definition of the responsibility of the holder of the authorization by including in the legislation or regulations, as clearly specified, the issues of civil nuclear liability. They should not be assumed rather they must be defined;
- Introducing in the law or regulations the concept of "civil liability even without fault" of the holder of the authorization and extend the same over all clandestine operators, and any holder of nuclear materials or radioactive materials;
- Extending the obligations of the license holder regarding the protection of the environment from radioactive radiation;
- Formally prohibit the discharge of radioactive waste in nature and establish by Decree or an independent mechanism to monitor the environmental impacts for activities using nuclear materials and facilities.

Improvement of the role of Government

At this level, it will be:

- Plan and define by Decree the modalities for the effective health care, total or partial and/or civil compensation by government for accidents caused by natural sources or abandoned radioactive waste that will not fit in the responsibility of the license holder;
- Define and adopt under Decree a nuclear national policy that addresses the protection of workers, the public and the environment against the dangers of ionizing radiation;
- Establish through a Decree National Rescue Plans in case of different types of nuclear emergency and radioactive accidents.

Safety transport of Nuclear Material

Here, it will be important to improve the provisions of the Law 017/2002 by incorporating safety requirements for the transport of nuclear and radioactive materials and extend and specify those measures in the Regulation for better protection.

Strengthen International Commitments

To enable the country to better protect its population and the environment in accordance with its international commitments, it is important to:

- Adhere to more international conventions to better take into account the relevant issues of security and nuclear safety as well as protection of the environment in general (particularly the adhesion to Conventions on nuclear civil liability, Convention on the assessment of environmental impact in a trans-boundary context,...);
- Ratify the international agreements signed within the framework of the IAEA so far not ratified and integrate them into national regulation;
- Ensure proper adaptation of international IAEA standards in legislation and national regulations;
- Conform existing national standards with international standards and par-

ticipate more actively in the concerts of nations dealing with the issues of protection of the population and the environment and take measures to adapt to the new energy policy.

2) Congolese institutional framework of nuclear and radiological risks prevention and management.

Among the state bodies and structures operating in the nuclear and radiological area of the Democratic Republic of Congo, we have:

- The National Committee for Protection against Ionizing Radiation (CNPRI in acronym), regulatory authority;
- The National Institute of Radiation Protection (INRP in acronym);
- The National Nuclear Security Council (NNSC);
- The Commissariat General a l'Energie Atomique (CGEA);
- Centre of Excellence for mitigation of risks related to chemical, biological, radiological and nuclear materials (COE/CBRN-DRC in acronym).

a) Institutional shortcomings

The normative gaps mentioned above often result in the functioning of the structures set up, by a total or partial inertia from acting in coordinated intervention to save the people and the environment exposed or affected by the dangers of ionizing radiation. We have discovered inter alia:

- The absence of a national emergency action plan, established by the regulatory body (CNPRI), unequivocally defining the roles of each of the aforementioned structures or state agencies;
- Insufficiency of updated technical equipment for assessment of the level of exposure, for decontamination operation and lack of expertise;
- Difficulties of funding, etc.

b) Possible institutional solutions:

The possible solutions at the institutional level concern:

Strengthening national agencies by:

- Strengthening agencies responsible for protecting the population and the environment:
- Increase funding for these services (operating and salary budget) and financing the supply of equipment missing or need to be replaced in favour of the nuclear research reactor in Kinshasa and see the possibility of declassify it and to acquire a more suitable reactor;
- Take significant steps to limit the dangers of erosion that threatens the site that houses the nuclear reactor;
- Train new technical personnel from different services for the prevention and management of radiation risks and equip the staff of these services working on nuclear safety with modern tools;
- Enhance institutional collaboration and clearly define responsibilities for each task in the event of intervention.

Establishing control mechanisms and regular evaluation for:

- Assessing regularly exposures levels in the services using nuclear and radio-

active material (internal evaluation and external evaluation against);

- Regularly evaluating the effectiveness of all the measures put in place (nuclear national policy, Program of actions, contingency plan in case of emergency, the level of contamination of the environment...);
- Applying and testing the inter-agency contingency plans put in place by simulation exercises, taking the necessary precautions not to expose people to hazards during these exercises, etc.

Technology transfer

The transfer of new technologies in the field is possible if, in one hand, the government develops its international cooperation with the IAEA for support in the negotiations of the acquisition of a new reactor, technical equipment needed for the reactor shutdown (in Kinshasa, DR Congo Capital city) and equipment for personal response services in the event of emergency; and in the other hand, with other international nuclear powers to benefit from their support for the revival of the Congolese nuclear ambitions with more tailored not only to the needs of the country but also of the region or sub-region (in terms of electricity, health, agriculture, etc...)

Training of agents, managers, technicians

The acquisition of expertise is a prerequisite for better protection against the risks of ionizing radiation. This may be possible if the government:

- Increases collaboration in terms of the training of technicians and their equipment;
- Permits exchange of experiences between the privileged administrative managers from different states;
- Strives for establishment of regional pools of prevention and management of mutual case of risks related to the field;
- Prioritize common response mechanisms of preparedness and response for nuclear and radiological accidents between neighbouring countries;
- Increase cooperation for the acquisition of new reactors capable of filling the electricity deficit in the sub/region.

5. Conclusion

The aim of this study is to verify whether the Congolese system for the prevention and management of risks related to nuclear and radioactive materials complies with international nuclear law and is effective for the protection of people and the environment.

To this end, we first collected, through treaties, conventions and other international norms, the relevant international rules. And we discovered that many conventions and treaties in the field of international nuclear law do not directly address issues of protection of persons and the environment against the dangers of nuclear and radiological materials, but merely contain some provisions on the subject, with nuclear security objectives taking precedence over safety objectives.

These international rules include instruments concluded under the auspices of

the United Nations, those concluded under the auspices of the International Atomic Energy Agency (IAEA), those concluded under the auspices of the OECD Nuclear Energy Agency (OECD/NEA), and others concluded at regional level, including within the European Atomic Energy Community (EURATOM) and within the African Union framework (Pelindaba Treaty).

After broadening our understanding of the international framework for the protection of people and the environment against the risks of nuclear and radioactive materials, we began by analysing the relevance of these international instruments in the Congolese legal context. Next, we examined the conformity of the Congolese legal system with the relevant international standards already found. At this level, the IAEA's safety standards were more specific as tools in our study than the treaties and conventions under its auspices which did not provide sufficient detail on the practices that States Parties must apply in order to comply with safety and security requirements.

Thus, we reviewed the IAEA standards where we found the basic principles, practices, requirements and guidelines that can assist States in implementing their commitments. However, when we wanted to know whether these standards are binding on Member States, we discovered through Article III of the IAEA Statute that the standards set by the IAEA have a recommendatory value for States, and are therefore not binding, except in the context of States seeking or receiving assistance from the IAEA and vis-à-vis the IAEA in fulfilling its mandate. Thus, outside these contexts, the State Party is free to implement or not to implement these standards in its national legislation. And even if the State chooses not to apply these standards directly, States should, at least on the basis of their commitments to the basic conventions and/or treaties, take appropriate measures to achieve the implementation of the protection of persons and the environment against the risks of nuclear and radioactive materials.

We then considered the desirability of implementing these standards and the benefits are indeed substantial, both in terms of basic principles, clarity and consistency of requirements and the adaptability of safety and security that States need for the protection of people and the environment. This is indeed the result of regular work carried out by State representatives and experts from international agencies and organisations in the field of protection against ionising effects. Thus, each State can adapt these standards to its own context.

We found those that were adapted to the situation in the Congo and it is on the basis of them that we assessed the conformity and effectiveness of the Congolese system.

This conformity analysis took place at three levels:

1) Identify the fundamental Congolese legal texts on the protection of people and the environment against ionising radiation and compare their conformity with the IAEA's basic safety principles;

2) Examine the requirements of the Congolese legal texts in terms of the obligations/responsibilities of each party and compare them with the IAEA's re-

quirements;

3) Verify the effectiveness of the Congolese system in practice: this requires knowledge of the services working for radiation protection, the cases of risks and problems they face, the mechanisms put in place to resolve them, the quality of the solutions...

This exercise had the advantage of showing more or less clearly the gaps within the regulations and within the institutions. On the basis of these gaps, we made suggestions to improve the system in order to better prevent, manage and if possible restore the situation of nuclear and radiological risks in the DRC.

Thus, if the DRC wishes to continue and propel its nuclear activity for peaceful purposes, or even to become an energy power or a champion of nuclear medicine, etc. for its benefit and that of the sub-region, a lot of efforts must be made to ensure better protection of the population and the environment against the risks associated with the use of nuclear and radioactive materials.

This implies, among other things:

- The definition of a national policy and actions plan for the protection of the population and the environment against ionizing radiation,
- The extension of the responsibility of licence holders,
- The need for the government to be subject to the damage and risks posed by those who have the authorization, and to other eventual risks,
- The strengthening of Congolese national institutions responsible for protecting populations against the risks of exposure to radioactive radiation,
- Development of national response plans for nuclear and radiation emergencies, etc.

To do this, the DRC must first strengthen the legal safeguards of its system to comply with current international nuclear safety standards. Second, greater efforts must be made to strengthen the autonomy of its institutions, in terms of equipment, expertise and funding for research for peaceful purposes, in order to ensure the easy and safe exploitation of nuclear and radioactive materials for the benefit of its population and even the regional community.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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